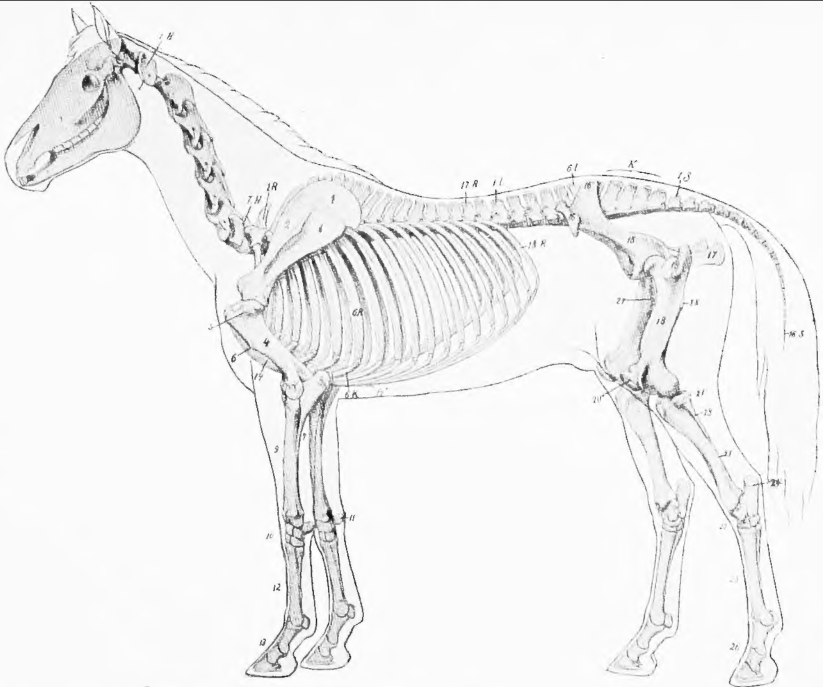

Skeleton with Outline of Contour of Body.

1.H., Atlas; 7.H., seventh cervical vertebra; 1.R., first thoracic vertebra; 17.R., seventeenth thoracic vertebra; 1.L., first lumbar vertebra; 6.L., sixth lumbar vertebra; K, sacrum; 1.S., first coccygeal vertebra; 16.S., sixteenth coccygeal vertebra; 6.R., sixth rib; 6.K., costal cartilage; 18.R., last rib; 1, scapula; 1′, cartilage of scapula; 2, spine of scapula; 4, humerus; 5, lateral tuberosity of humerus; 6, deltoid tuberosity; 7, shaft of ulna; 8, olecranon; 9, radius; 10, carpus; 11, accessory carpal bone; 12, metacarpus; 13, digit; 14, sternum; 14″, xiphoid cartilage; 15, ilium; 16, 16′, angles of ilium; 17, ischium; 18, femur (shaft); 19, trochanter major; 20, patella; 21, tibia (shaft); 21′, lateral condyle of tibia; 22, tarsus; 23, fibula; 24, tuber calcis; 25, metatarsus; 26, digit; 27, trochanter minor of femur; 28, trochanter tertius of femur. (Ellenberger-Baum, Anat. für Künstler.)

THE HORSE

in

HEALTH AND DISEASE

A TEXT-BOOK PERTAINING TO VETERINARY SCIENCE FOR AGRICULTURAL STUDENTS

BY

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ILLUSTRATED

PHILADELPHIA AND LONDON

W. B. SAUNDERS COMPANY

1915

93

PRINTED IN AMERICA

PRESS OF
W. B. SAUNDERS COMPANY
PHILADELPHIA

PREFACE

THIS book is designed as an introductory text to the study of veterinary science in agricultural schools and colleges. It is hoped that stockmen may also find it useful as a reference and aid in the care of animals. In Part I an effort has been made to correlate the structure and function of each organ of the body, and to show how the hidden parts are related to the form, movements, and utility of the animal. In Part II the causes, methods of prevention, and effects of disease are considered.

The horse has been taken as a type, for the reason that it is customary to use this animal as a basis for comparison with our other domestic animals. Reference to cattle, sheep, and swine has been purposely omitted to keep the book within convenient size for use, and so that the teacher may supplement the text with lectures relative to these animals, as his judgment directs. It is recommended that the class-room instruction be amplified with demonstrations in the laboratory, stock-judging pavilion, and clinic whenever possible, as material help is derived from direct observation.

Lack of training in matters pertaining to the health of our horses and knowledge about nursing them when they are sick are largely responsible for the loss from disease during 1913 in the United States of over 500,000 head, valued at $58,000,000. If this book aids in preventing such a stupendous loss in the future, it will have justified all efforts that have been made in its preparation.

One difficulty encountered in writing the manuscript is that of selecting the most suitable material from the immense amount

available. Another is the use of technical terms. More of the latter have been introduced than in most books on agricultural subjects, the authors of which claim that they have studiously avoided scientific names and substituted the simplest terms. This is not only objectionable with a subject like veterinary science, which is founded on practically all of the natural sciences, but is an assumption that both the student and educated farmer are unable to understand the English language. Once the meaning of these terms is learned, no great difficulty should be experienced in reading veterinary literature intelligently.

In preparing this volume I have drawn largely on lecture notes that have been accumulated during the past eight years while acting as an instructor in veterinary and agricultural colleges and lecturer at farmers' institutes. Among the authorities most liberally consulted are "Anatomy of the Domestic Animals," Sisson; "Veterinary Physiology," Smith; "Veterinary Physiology," Paton; "Diseases of Animals," Mayo; and "The Army Horse." These publications are recommended for reference purposes.

Particular thanks are due to my associates, Professor A. S. Alexander and Dr. Herbert Lothe, for helpful suggestions, as well as assistance in reading proof.

F. B. H.

MADISON, WISCONSIN,
August, 1915.

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PART I

ANATOMY AND PHYSIOLOGY OF THE HORSE

CHAPTER I

CHARACTERISTICS OF THE ANIMAL BODY

DEFINITIONS AND CLASSIFICATIONS

Veterinary science is a systematized knowledge of the structure, functions, derangements, and methods of preventing and treating diseases of domestic animals. It is a more inclusive term than **veterinary medicine,** which is restricted to the art and science of medicine as applied to domestic animals.

When the study of a subject so comprehensive as veterinary science is begun, there are many words to be learned that are new to most students. This is necessary because nearly all of the medical sciences must be drawn upon as a basis for the work. Furthermore, the language of medicine differs materially from that in ordinary use, which alone is a sufficient reason for introducing at once definitions of the terms that must be frequently employed in the subsequent pages. Most of the unfamiliar words will be defined when the subject to which they particularly apply is discussed. Definitions of the terms upon which the work as a whole is based follow:

Anatomy is that branch of science which deals with the structure of living things. Some knowledge of gross anatomy must have been possessed by the earliest scientists, for a crude dissection of the animal machine was made then as now when carcasses were prepared for food purposes.

Histology is a description of the minute structures of the body, and includes a microscopic study of the cells and tissues of which the body is composed.

Physiology deals with the functions of the different organs in the living body. For example, the function of the liver is to secrete bile; the udder, milk; the kidneys, urine.

Pathology describes the derangements of the different parts and organs due to diseases. Until we become familiar with normal body processes, pathologic changes cannot be recognized, so this subject will not be considered until after the preceding have been studied.

All are more or less conversant with animals as they live, move, feed, grow, and raise their young. Most of us have remained satisfied with such knowledge, and have only a very hazy idea of the wonderfully intricate machinery which lies concealed in the animal body. This is not strange when we consider that for many generations men failed to discover even the fundamental truths of the mystery of life. Anatomy and physiology, as our definitions show, deal respectively with the study of structure and function. It is through these that we will learn something about the complex body of the horse and be better enabled to render intelligent aid to this noble animal when occasion demands.

The position of the horse in the animal kingdom must first be established. All the domesticated animals in North America belong to the sub-kingdom of *vertebrates*. The distinguishing feature of this group is the vertebral column or back-bone, made up of segments called vertebra, from which the name of the sub-kingdom is derived. Vertebrates are further characterized by never having more than two pairs of limbs, which are always attached to the lower part of the body.

In fetal life the body of the vertebrate is traversed by an unjointed cartilaginous rod. In the lower vertebrates this rod persists throughout life, but in the higher it is replaced by the true vertebræ.

A cross-section of the body of a vertebrate animal shows two cavities, with the vertebral column lying in the partition between the two. The upper cavity is tube-like in form and contains the spinal cord and brain of the central nervous system. The lower cavity contains the alimentary canal, heart, lungs, and other soft organs. Invertebrates—insects, for example—have but one cavity

common to the above-mentioned organs and the nervous system lies with the soft organs.

Vertebrates are divided into the following five classes: (1) Fishes; (2) Amphibians; (3) Reptiles; (4) Birds; (5) Mammals.

The *mammals* are of most importance and include the horse and our other large domesticated animals. As a class, mammals are air-breathing, warm-blooded, produce their young alive and nourish them for a variable period on a secretion from the mammary glands, and have appendages from the skin in the form of hairs. They are divided into a great many orders. Of these, the horse and ass belong to the *ungulates*. All the members of this order are characterized by having their back teeth adapted to crushing and grinding their food, in being destitute of a clavicle, in never possessing five digits, and in having the terminal bone of each digit invested by a thick horny covering or hoof.

THE CHEMISTRY OF THE ANIMAL BODY

It is practically impossible to determine the chemical composition of living organic matter because changes are constantly going on in it. Analyses of dead tissues show that the compounds are very complex, yet not more than twelve separate elements can be demonstrated. This is a relatively small number when compared to the eighty or more chemical elements known to science. Of these twelve elements only the following five are present in considerable quantities—carbon, hydrogen, oxygen, nitrogen, and sulphur—which together constitute 99 per cent. of the body weight. These are linked together in different ways to form molecules of enormous size. Inorganic salts of sodium, potassium, calcium, magnesium, and iron, in the form of chlorids, sulphates, phosphates, and carbonates, are found in the ash and make up the remaining 1 per cent.

Carbon enters the animal's system as a constituent of organic compounds, and leaves it either as carbonic acid gas or in simple organic compounds, such as urea.

Hydrogen occurs in nature in combinations like water and ammonia. It is in these forms that it is taken up by plants and converted into a constituent of organic compounds. Hydrogen is given off by the body in the same forms as acquired, that is, as water and in combination with nitrogen to form ammonia, and as a constituent of organic compounds.

Oxygen is the only element entering the body in a free state. It is essential to the animal, for life cannot exist for any length of time without it.

Nitrogen enters the body in large amounts in protein combinations, and leaves it as urea and other products which easily yield ammonia.

Sulphur is present in the smallest amount of any of the five principal constituents of the body. It is taken into the body as a part of the protein molecule, and is largely excreted in the urine as sulphates.

It is customary to divide the constituents of the animal body into:

(I) **Inorganic compounds,** which include the mineral elements found in the bones and teeth, also the water and salts of the body. They are recovered from the ash after burning the body. They comprise various salts, of which calcium phosphate predominates. None of them contains carbon. Approximately 80 per cent. of the total ash compounds of fat animals are found in the bones.

(II) **Organic compounds,** which make up by far the largest portion cf the animal body. They are characterized by containing carbon and are subdivided for study into: (1) nitrogenous substances; (2) non-nitrogenous substances.

(1) The **nitrogenous substances** include all the organic compounds having nitrogen in their molecules. They have various characteristics and properties. For a complete discussion of these substances references should be made to text-books on organic chemistry. Collectively this group of highly complex compounds is known as proteins.

Proteins comprise a large part of the solid matter of the muscles, tendons, blood, skin, etc. They are mostly colloidal in nature, only a very few having been obtained in crystalline form. Chemists have not been able to synthetize any but the very simple proteins. One characteristic of proteins is their inability to diffuse through an animal membrane. The decomposition products of proteins are varied and numerous. Carbonic acid, water, urea, and uric acid are the final end-products, but many intermediate substances, such as glycin and leucin, which are really cleavage products of proteins, occur in the course of their destruction.

Albuminoids are closely allied to the proteins, but differ from them by being insoluble in all neutral solvents. The best-known

members of the group are collagen, gelatin, chondrin, elastin, and keratin. *Collagen* is the intercellular substance of connective tissues, and under the name of "ossein" forms a large part of the organic basis of bones. By boiling with water it is readily converted into *gelatin*, which is similar to it. *Chondrin* is obtained from the ground substance of hyaline cartilage. *Elastin* is obtained from the fibers of elastic tissues. *Keratin* is the characteristic constituent of epidermal structures, such as hair, nails, feathers, and horn. It contains from 3 to 5 per cent. of sulphur, a large portion of which is easily set free as hydrogen sulphid, and will combine with other substances, particularly lead solutions, to form the black sulphid of lead, which is used for hair dyes.

Enzymes are another class of organic substances, probably of a nitrogenous nature. Their mode of action is yet a mystery. They are of supreme importance to the body and will be referred to more in detail when the various organs manufacturing them are considered.

Other substances which are properly classed as nitrogenous compounds are various **pigments** of the body, for example, the bile-pigments, the blood-coloring matter, the pigments of the skin, hair, horn, eye, and that found in melanotic tumors so common in white and gray horses.

Nitrogenous fats, such as *lecithin,* need but passing mention.

Amino-acids are simple nitrogenous bodies formed from the proteins of digested foods, and are used by the animal to build up its tissues.

Urea and **uric acid** are a group of nitrogenous waste compounds found in the excreta of the body.

(2) The **non-nitrogenous substances** are fats and various carbohydrates.

Fats contain the same elements as the carbohydrates, but the oxygen is present in smaller percentage, and not present in the proportion to form water. The principal fats present are stearin, palmitin, and olein. In the body fat is found interwoven or intermingled with the muscles and the vital organs and in the fatty or adipose tissue lying under the skin. Chemically, fats are esters of glycerol and the fatty acids. The amount of fat in the body varies with the age and condition of the animal. It is useful in forming a covering or insulator to the body and to prevent rapid radiation

of heat. A fat animal, therefore, needs less food than a lean one to maintain itself.

Carbohydrates occur chiefly as monosaccharids, disaccharids, and polysaccharids. Milk-sugar or lactose is a constituent of milk and belongs to the group of disaccharids. The more highly organized polysaccharids are represented by glycogen, or animal starch. It is found in the liver, muscles, and other tissues of the body and occurs in large quantities in all fetal tissues.

The animal body contains about 56 per cent. water, 21 per cent. fat, 18 per cent. protein, and 5 per cent. ash. From these figures it will be seen that water is present in the largest percentage of any of the constituents of the body. An analysis of the composition of the body of the horse is not available. The Rothamsted Station has determined the percentage composition of the whole bodies of the pig, calf, ox, and sheep both in fat and half-fat conditions. On the strength of this work it may be concluded that the young growing horse requires a plentiful supply of protein and ash to make the most economical gain, while a mature horse can be maintained on a ration containing relatively smaller amounts of these substances.

THE CELLS OF THE ANIMAL BODY

The body is composed of countless millions of microscopic elements called *cells*. The cell is the smallest unit of life. Cells are grouped together to form, first, the tissues, which in turn form the various organs of the body. To understand the numerous functions of the intact body the cellular structure must be studied. This can only be done satisfactorily with the aid of a microscope, so is beyond the scope of this book.

By way of introduction to the study of histology, it may be stated that all *typical animal cells* have certain characteristics (Fig. 1). Each possesses a cell body or protoplasm, a cell nucleus or germ center, and a nucleolus. Most of them also have a cell wall to confine the essential parts just mentioned.

Protoplasm is the material basis of the cell and the life processes. It is a transparent, viscid substance to the sight and touch. On close examination it is found to be a complex mass of organic material held together by a very delicate meshwork of fibers. In plants and animals protoplasm is essentially the same.

Three well-known physical forces operate in living protoplasm.

They have been described by Wentworth as follows: First, *capillarity*, or the power that makes water stand higher at the edges of a glass than in the center, exerts a profound influence on the nature of the chemical reactions that take place. One example will suffice: A glass plate placed over a tumbler practically filled with water may leave a small bubble of air beneath. Under the influence of

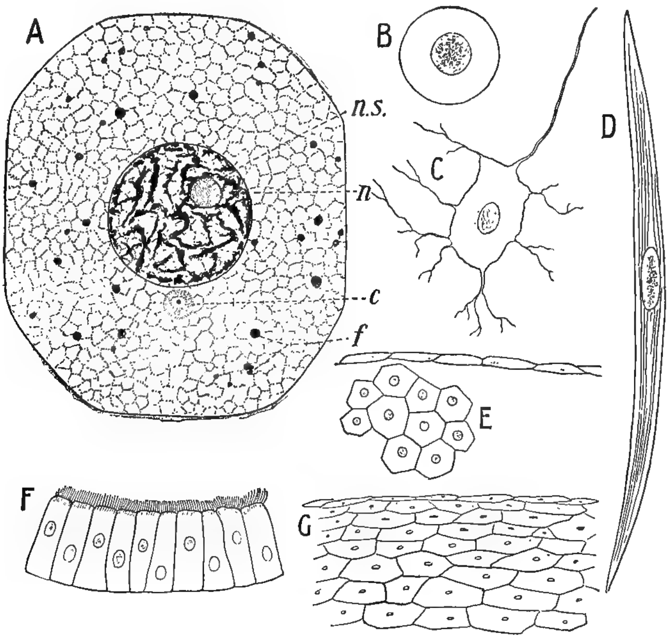

Fig. 1.—Different types of cells composing the body. *A*, Typical cell showing: *c*, centrosome; *f*, food granules in the protoplasm; *n*, nucleus; *n.s.*, nucleolus; *B*, complete cell; *C*, nerve cell with axon and dendrites; *D*, involuntary muscle-fiber; *E*, endothelial cells; *F*, ciliated epithelial cells from trachea; *G*, stratified squamous epithelium from the skin. (Jordan and Kellogg, Evolution and Animal Life.)

capillarity, however, this bubble can be easily replaced with water by sliding the plate slightly to one side and allowing a few drops to fall on the exposed surface of the water. Second, *surface tension*, the force that permits water to "heap up" slightly above the top of a glass so that it is more than level full, or that lets a dry needle float on the surface of water, keeps the compounds of different

density separate, so that each may be almost as distinct from the other as though it occupied a different test-tube. Third, *osmosis*, the force that permits liquids of different densities to interchange through bladder membranes, allows some interchange of the products of one reaction through the different compounds of the protoplasm.

Living matter (protoplasm) is essentially something that performs a function. Energy is either being stored or liberated. This process is called *metabolism* and is divided into anabolism and katabolism. *Anabolism*, or the building-up process, is characteristic of plants. In the presence of sunlight the green leaf takes carbonic acid gas from the air, and water with mineral elements from the soil, and evolves a more complex substance from them that possesses a high degree of energy. Our animals benefit from this and find here materials to support their breaking-down process, or *katabolism*. The energy thus stored by the plant is released to the animal for his use. The combination of these two forces is one of the safest methods of distinguishing simple living matter from non-living.

From a physiologic standpoint we may group the attributes or functions of living cells under ten headings:

1. **Ingestion** is the power of taking food particles into the protoplasm. In the simplest cases it probably represents merely the flowing of the protoplasm around the food.

2. **Secretion** is the response of the protoplasm to these food particles. It corresponds in a primitive way to the production of the saliva in the mouth and the gastric juice in the stomach. It is simply the production of certain juices, activators, enzymes, or hormones, as they are variously called, that have a chemical action on the food.

3. **Digestion** is the direct action of these secretions on the food particles. It so changes the chemical composition of the food that it becomes available for energy, or for the building up of the protoplasm. It is possible that these two uses are similar.

4. **Assimilation** is the incorporation of the digested food particles into the protoplasm. In simple forms it is the equivalent of anabolism.

5. **Katabolism** is the process of liberating the energy stored up in the protoplasm. It may be termed a tearing-down function, in the sense that complex chemical compounds are torn down to

yield their quota of energy. Complementary to this is the excretion of the waste-products of energy production and also those of digestion and assimilation.

6. **Irritability** is the sensitiveness that the protoplasm shows to stimulation by outside objects. It is the foundation of the forces that have become so highly developed and specialized in the nerve-cells. This response to a stimulus is more highly developed in the mammalia than in reptiles, and in the latter than in fishes.

7. **Motility,** or the power of movement, is one of the chief means of recognizing living matter. Its simplest manifestation, a flowing of the protoplasm due to changes in surface tension, is represented in the white cells of the blood that act as scavengers and destroy disease-producing organisms. Contractility, a function of muscle-cells, is a good example of this attribute.

8. **Growth** is one of the essentials that has come to have an extreme economic value. It needs little discussion, as all can witness it, and further, because the scientist is but little nearer its fundamentals than the layman. Living things grow by absorbing new material from without and transforming it into substances of their own bodies. Growth takes place only through a certain period, being rapid during youth, about stationary at maturity, and negative during old age. In fact, there is usually a gradual decay and wasting away during old age, finally leading to a complete cessation of the vital processes. This is spoken of as senile degeneration. For each species there is a limit to this period of growth: most small animals develop completely in a year, horses take four to five years, and man approximately twenty-one years. The average height of man is 5 feet, 8 inches. The average weight of the horse is between 1000 and 1100 pounds. Giants and dwarfs are always abnormal productions and represent pathologic changes. These abnormalities are not often transmitted to the offspring.

9. **Reproduction** is probably the most remarkable and interesting of all the attributes of the living animal. Detailed consideration of this characteristic will be left until the reproductive organs of the body have been studied, when it can be more easily understood.

10. **Response to environment** is the power that induces the production of substances that help neutralize disease, repair wounds, and adapts the body to its physical surroundings.

The cells composing the animal body are not quite so well defined as those in plants, neither are their walls so nearly complete. All cells are of a common descent, but they have acquired widely different characters and functions. This specialization manifests itself by a grouping of cells which have work of a similar nature to perform. For instance, the fat-cells are very passive, and as they perform the function of storing reserve food material they are placed in those parts where least interference will be had with the more active parts. The cells lining the air-passages are very active and their cilia are in continual motion. Other cells, such as certain kinds found in the blood, are still different, and possess the power to move from place to place. By developing along one definite line, cells lose their primitive power to receive and utilize all kinds of food. Nature has, therefore, provided certain standard forms of food for their sustenance. Food is supplied to each cell and waste is removed by a special transporting fluid, the blood. The exact manner by which this exchange is made possible will be discussed in later chapters.

THE TISSUES OF THE ANIMAL BODY

A tissue is a collection of more or less similar cells possessing functions somewhat alike. *Body tissues* are divided into vegetative tissues, which support, bind together, protect, and nourish; and master tissues, which consist of the muscles and nerves.

A. The **vegetative tissues** may be divided into (I) epithelial tissues and (II) connective tissues.

I. **Epithelial tissues** consist of large numbers of cells and a very small amount of intercellular substance. They develop from the epiblast and hypoblast of the embryo and are found on or near surfaces of the body. There are four kinds of epithelial tissue, namely: (1) squamous epithelium; (2) columnar epithelium; (3) secreting epithelium; (4) ciliated epithelium.

1. *Squamous epithelium* is primarily a protective tissue and is composed of flat, scale-like cells. They may be in single layers like the cells lining the air sacs of the lungs; or stratified and composed of several layers piled one upon the other like the cells of the skin, hair, horns, hoofs, and nails (see Fig. 1). The upper layers are farthest from the nutrition supply, and so lose their sensitiveness and become hard and act as good protective agents. Poisons can-

not readily pass through, and chemicals do not act easily on, intact epithelium. Their function is chiefly to protect the sensitive structures beneath, like the "quick" under the hoofs. As a rule, all epithelial tissues are capable of rapid replacement when injured or destroyed. This makes them well fitted to cover surfaces exposed to injury.

2. *Columnar epithelium* derives its name from the shape and arrangement of its cells, which are longer than they are broad. It is found lining the stomach and intestines. The chief function is to take up matter digested by these organs and to pass it on to the blood.

3. *Secreting epithelium,* as the name indicates, has to do with the secreting tissues of the body, and is found composing the various secretory glands which are outgrowths of the epithelium. The simplest form of gland is the simple tubular. Branched and compound glands are more complex. Depending upon the substances produced, secretory epithelium may be either—

(A) Mucin-secreting epithelium, which is the variety found wherever mucous membranes are located, that is, in all passages which communicate either directly or indirectly with the outer air. It secretes a slimy substance known as mucin for lubricating the mouth, stomach, intestines, and other organs. Mucin is of great importance in the animal economy. When precipitated and freed from water it is white and amorphous. On the addition of water it swells and forms a transparent glairy mass. Its function is to act as a lubricant.

(B) Zymin-secreting epithelium forms the various juices in the stomach and bowels which act upon and digest the food. The activity of the secretions is due to the presence of enzymes, zymins, or hormones. During the activity incidental to digestion these cells give off or secrete large quantities of enzymes. When this process ceases, the cells, now in the so-called resting stage, are storing up their product for future use. Carefully prepared specimens for microscopic study clearly demonstrate that peculiar granules are responsible for the action of the secretion. These disappear with glandular activity.

(C) Excreting epithelial tissues pass substances out of the body which are of no further use in the animal economy, *e. g.*, the epithelium of the kidneys, sweat glands, and mammary glands. They not only have the power of taking up material from the blood

and passing it out (urine), but they may even alter it greatly before passing it out (milk).

4. *Ciliated epithelium* is characterized by little hair-like processes called cilia (see Fig. 1). These cilia vary in length, depending upon their location. In the living state they are in constant motion like a grain field waving in the wind, each cilium being bent down in one direction and then again assuming the erect position. All cilia of an organ work harmoniously in the same direction, the motion begins at one end of the surface and ends at the other. The function of this tissue is to work foreign material from the inner parts of the body out and finally to expel it.

II. **Connective tissues** are derived from the mesoblast of the embryo. They are primarily to support and hold more highly specialized, active tissues in position. They are composed of but few cells and a large amount of intercellular or cementing substance, which, though outside the cells, has been derived from them. The activity of the constituent cells is confined chiefly to producing and maintaining the tissues and to restoring them when injured. After injury to the physiologically more active tissues with less regenerative power, connective tissues may be produced to take their place. An example is seen in cirrhosis of the liver, where the active gland cells are to some extent replaced with fibrous tissue. Connective tissues may be divided into three classes: fibrous tissue, cartilage tissue, and bone tissue.

1. *Fibrous tissue* is composed of bundles of minute fibers. It is of two varieties: white fibrous and yellow elastic.

(A) The white fibrous is found as a connecting tissue framework in various parts of the body. Tendons and ligaments are composed of it.

(B) Yellow elastic tissue is firmer than the white fibrous and has more elasticity. It forms the large ligamentum nuchæ that stretches from the head to the withers.

2. *Cartilage tissue* is glass-like in appearance, translucent, homogeneous, tough, and of elastic consistency. It cuts like cheese with a knife and is commonly named "gristle." Cartilage cells are peculiar in character and relatively few in number. All cartilage in the body is surrounded by a membrane known as the perichondrium, a fibrous tissue which carries blood-vessels to nourish the cartilage cells. In the embryo most bones are preceded by cartilage; later this is usually replaced by bone tissue. The rings of the

trachea, the epiglottis, and the covering at the ends of long bones are examples of cartilaginous tissue which persists in the mature animal.

3. *Bone tissue*—the skeleton or great supporting framework of the mature animal—is formed by a deposit of earthy salts. Bones are composed of organic and inorganic matter. The former constitutes about one-third the total amount, and when freed from the inorganic substances is known as ossein, a form of gelatin. This may be demonstrated by soaking a fresh bone in weak hydrochloric acid to dissolve out the mineral portions (decalcification). The organic matter gives bone its elasticity and tenacity. The inorganic or mineral matter constitutes the other two-thirds and is in the form of—

Calcium phosphate	57.35 per cent.
Calcium carbonate	3.85 per cent.
Magnesium phosphate	2.05 per cent.
Sodium salts	3.45 per cent.
	66.70 per cent.

The inorganic matter renders bone hard and dense. This combination of animal and mineral substances gives solidity to the bones, yet elasticity enough to prevent fracture under ordinary circumstances. It is very difficult to break a green bone on this account.

Histologically, bone is found to be composed of a series of bars and plates arranged so that blood-vessels and nerves may freely pass between them. This arrangement is so uniform that it has been given the name Haversian system. Each bone represents a great number of such systems.

On sectioning a bone there are revealed two varieties of bone texture: the outer or compact tissue, and the inner, spongy or cancellated tissue (Fig. 2).

Compact bone tissue is dense, close grained, and varies in thickness. In long bones it occurs in greatest amount in the shaft, the center of which is almost exclusively composed of it. Toward the ends of long bones it gradually diminishes in thickness until at the extremities it forms only a shell-like covering. On account of its resistance it is found in abundance wherever great strain is placed on a bone. In the cannon bone it is thick in the center, but thicker in front than behind, and on the inside than outside, in correspondence with the lines along which the greatest weight of the body falls.

Cancellated bone tissue is porous in appearance and composed of great numbers of little bony plates and spicules surrounding

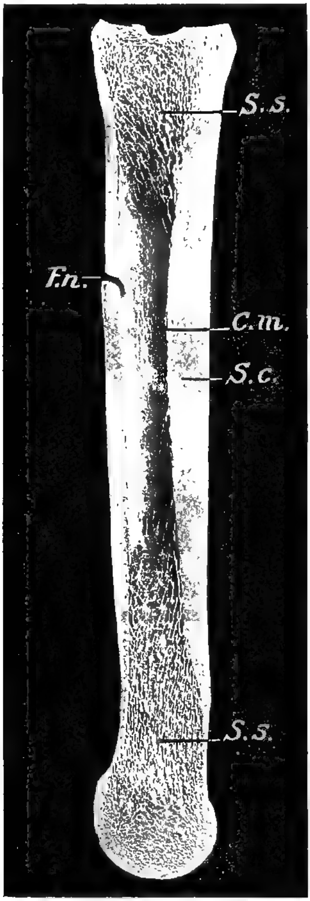

Fig. 2.—Sagittal section of right large metatarsal bone: *S.c.*, Compact substance; *S.s.*, spongy substance; *C.m.*, medullary cavity; *F.n.*, nutrient foramen. Note the greater thickness of the compact substance of the anterior part of the shaft. (Sisson, Anatomy of Domestic Animals.)

spaces that are filled with red marrow in the living animal. There is little spongy tissue in the centers of the shafts of long bones, but

at the extremities it increases in amount and forms nearly the entire mass. It is less resistant than compact bone tissue, but is useful in giving the bones surface without adding to the weight, *e. g.*, ends of bones where they articulate to form joints.

When dried and bleached, bones are white in color with a tinge of yellow. When exposed in the living animal the white is tinged with bluish-pink, due to the blood in the innumerable small vessels of the bone. Overlying the compact tissue of a fresh bone is found a thin, tough, unelastic membrane called the periosteum. It is present on all parts of the bone except the articular surfaces, where it is replaced by cartilage. Blood-vessels and nerves for the bone run in the periosteum.

Bone-marrow is the soft material found in the center of bones. Marrow is of two varieties—red and white. The red marrow produces certain kinds of red blood-cells. It is found in the shafts of long bones and in flat bones. In the young animal it is relatively much grater in amount than in the old animal. Yellow marrow is about 96 per cent. fat and appears to have no particular function. It replaces part of the red marrow in the bones of mature animals.

The bones of young animals may become permanently distorted under the weight of the body or the traction of the muscles attached to them. In old animals the organic matter in the bones is replaced to a large extent by inorganic matter, thus rendering them much more brittle and liable to fracture.

B. The **master tissues** comprise the muscles and nerves. They will be described in special chapters, as they are of sufficient importance to deserve more detailed consideration than can be given here.

THE ORGANS OF THE ANIMAL BODY

Organs are well-defined parts, such as the heart, liver, or brain. They are composed of several kinds of tissues, but possess, as a rule, only one or, at most, a few forms of activity. There are several methods of classifying the various body organs for study. The systematic method is most suitable for our purposes. It divides the body into systems or groups of organs as follows:

(1) Skeletal system, or organs of support.
(2) Muscular system, or organs of motion.
(3) Digestive system, or organs of digestion.
(4) Respiratory system, or organs of respiration.

(5) Urogenital system, or organs of urination and reproduction.

(6) Circulatory system, or organs of circulation.

(7) Nervous system, or organs of innervation.

Descriptive terms are employed to indicate the exact position and direction of parts and organs of the body. These terms refer to the horse in the ordinary standing position and must be learned. The surface directed toward the ground is termed *inferior* or *ventral*, and the opposite surface is *superior* or *dorsal*. An imaginary median plane divides the body into halves. A structure or surface which is nearer than another to the median plane is *internal* to it; and an object or surface which is further than another from the median plane is *external* or *lateral* to it. The head end of the body is termed *anterior*, *cephalic*, or *cranial;* and the tail end, *posterior* or *caudal*. *Proximal* and *distal* represent distances from the vertebral column.

CHAPTER II

THE SKELETAL SYSTEM

KINDS AND USES OF BONES

THE *skeleton* may be divided for description into an axial portion, consisting of the bones of the head, trunk, and tail, and an appendicular portion, which comprises the bones of the limbs. The number of bones in the skeleton of an animal varies with the age, owing to fusion of bones which are separate in the young. Adult horses have 250 bones as a rule. When dried the bones constitute from 7 to 8.5 per cent. of the body weight. The study of the bones is called **osteology.**

The skeleton serves as a support or framework for the more delicate and softer parts of the animal. The bones of vertebrates are embedded in the soft structures of the body, and are, therefore, termed the **endoskeleton.** Invertebrates, in contradistinction, often have a skeleton placed outside the softer parts, as in the case of the lobster's shell; such an arrangement is called an **exoskeleton.** Occasionally a bone is found embedded in a soft organ and does not articulate with the general skeleton; it belongs to the so-called **splanchnic skeleton.** The *os cordis* in the ox heart, *os penis* of the dog, and *os rostri* in the snout of the hog are examples of bones belonging to the splanchnic skeleton.

It is customary to divide the bones according to their shape into four classes, as follows:

1. Long bones, which have a marrow cavity and consist of a shaft and two extremities. They are found exclusively in the limbs and act as columns of support, *e. g.*, femur or thigh bone.

2. Flat bones, which protect organs and afford extensive surface for the attachment of muscles, *e. g.*, scapula or shoulder-blade.

3. Short bones, which are cubical in form and occur chiefly in compound joints, *e. g.*, the hock.

4. Irregular bones, which include all others not coming in the above groups. They are all single and lie along the median plane, *e. g.*, vertebræ.

BONES OF THE AXIAL SKELETON

The *axial skeleton* consists of the head, vertebral column, and thorax. Each of these parts is important enough to deserve special study.

The **head** or **skull** is composed of 34 bones (including the small bones in the ears). They are divided into the *cranial* bones, which enclose the brain and the essential organs of hearing, and the *facial bones*, which include all the other bones of the head.

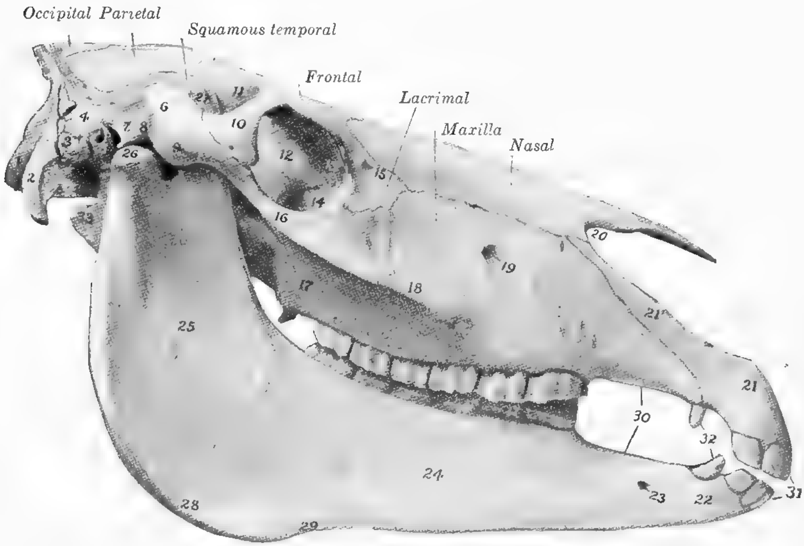

Fig. 3.—Skull (right view): 1, 2, Occipital bone; 3, 4, 5, 6, 7, 8, 9, processes of temporal bone; 10, 11, 12, parts of frontal bone; 13, 14, 15, lacrimal bone; 16, malar bone; 17, tuberosity of maxilla; 18, facial crest; 19, infra-orbital foramen; 20, nasomaxillary notch; 21, body of premaxilla; 21′, nasal process of same; 22, 23, 24, 25, 26, 27, 28, 29, mandible; 30, interdental space; 31, incisor teeth; 32, canine teeth; 33, hyoid bone. (Sisson, Anatomy of Domestic Animals.)

Most of the bones of the skull are flat bones (Fig. 3). There are only two freely movable joints between the bones of the head, the articulation of the lower jaw and that between the hyoid bone and the base of the skull. All other unions are by connective tissue and are immovable.

The bones of the cranium are the occipital, sphenoid, ethmoid,

interparietal, parietal, frontal, and temporal. The first four are single, the others paired.[1] They enclose the cranial cavity.

The bones of the face are of most importance to the horseman, for they carry the teeth. They are the maxilla, premaxilla, palatine, pterygoid, nasal, lacrimal, malar, superior and inferior turbinals, vomer, mandible, and hyoid. The last three are single, the others paired. They form the walls of the oral and nasal cavities. The shape of the nose and the coarseness or fineness of the head is determined by these bones.

The **maxillæ** are the principal bones of the upper jaw and carry the upper molar teeth. They are situated on the lateral aspects of the face. Each presents two surfaces. The external surface is convex, especially in the young animal. The prominent ridge noted on this surface is the facial crest. A little above and in front of this crest is the infra-orbital foramen. The internal surface is concave, smooth, and forms part of the wall of the nasal cavity. A ridge gives attachment to the inferior turbinated bone, above which is the lacrimal canal. Springing medially from the lower part is the palatine process, which forms a large portion of the hard palate and meets its fellow at the median plane. The inferior border has six alveoli for the upper molar teeth.

The **premaxillæ** are situated in front of the maxillæ. They are strongly developed anteriorly. Each has three alveoli for incisor teeth. The palatine processes project backward to form the anterior part of the roof of the mouth.

The **palatine bones** are small and may be considered as extensions to the hard palate.

The **pterygoid bones** are thin, strap-like attachments to the palatine bones.

The **nasal bones** form most of the roof of the nasal cavity. The dorsal surface is convex, the ventral concave and provides attachment for the superior turbinated bone. The anterior extremity is pointed, thin, and free.

The **lacrimal bones** are placed one in front of each eye.

The **malar bones** are situated below the lacrimal bones and correspond to the cheek bones of man.

The **turbinated bones,** four in number, two on each side, divide the nasal cavity into three passages. The bones are very delicate

[1] The student should learn the relative positions of these bones, but need not be required to describe each in detail.

and are covered in the living animal with mucous membrane. The anterior extremity of each bone is prolonged to the nostril by a plate of cartilage.

The **vomer** is a single bone placed in the median plane. It is molded to form a groove for the reception of the septal cartilage of the nose.

The **mandible,** or **lower jaw,** is the largest bone of the face. It is composed of a body and two branches. The body is the anterior part, which lodges six incisor teeth. Behind these, in the male on each side, is an alveolus for a canine tooth. The branches diverge backward from the body to form the submaxillary space. Each branch has a horizontal and a vertical part and presents two surfaces, two borders, and two extremities. Both surfaces of the horizontal part are slightly convex and smooth. The superior border has six alveoli for the lower molar teeth; the inferior border is thick and rounded in the young animal, but becomes thin and sharp in the old. The vertical part is wide and thin; the external and internal surfaces are concave and rough and lodge the powerful muscles of mastication. The anterior extremity joins the body, while the posterior presents an articular condyle for the temporal bone. A thin, flat process projects up from the front of this articular surface.

The **hyoid bone** is situated between the vertical parts of the mandible. It supports the root of the tongue, the pharynx, and the larynx.

Air-sinuses are spaces or cavities between the bones in the head. They add to the volume of the head without increasing its weight. In the fresh state they are lined with a continuation of the mucous membrane from the nose, with which they communicate by means of a small slit-like opening. There are four pairs of sinuses, named the sphenoidal, frontal, superior maxillary, and inferior maxillary. Of these, the *superior maxillary sinus* is the largest and most important. It communicates freely with the frontal sinus, but is separated from the inferior maxillary sinus by a thin, imperforate plate of bone. The roots of one or more teeth are seen in the sinus covered by a thin layer of bone.

The **vertebræ** are divided into five regions or groups, designated as cervical, thoracic, lumbar, sacral, coccygeal. Each group has a typical number of segments as shown in the following formula:

$$C_7T_{18}L_6S_5Cy_{15-21}.$$

Individual vertebra in each group closely resemble each other. All the vertebræ are constructed on a common plan, so a description of a typical member will serve as a basis, and any marked deviation from this plan will be noted afterward.

A *typical vertebra* presents the following features: A *body,* which is a cylindrical mass of bone upon which the other parts are built up. The upper surface of the body is flattened and forms the floor of the spinal canal. The anterior extremity presents a convex head to articulate with the posterior concave surface of the preceding vertebra. Between each two vertebræ there is a cartilaginous disk which binds the bones firmly together. An *arch,* which is built up on the upper surface of the body and completes the canal for the spinal cord. The *processes,* which are of three varieties: (1) articular processes, which project forward and backward from the arch; (2) transverse processes, usually two in number, which project outward from the lower part of the arch; (3) a spinous process, which is single and projects upward from the arch.

The *cervical vertebræ* form the skeleton of the neck. There are seven bones in this group. The first two are modified so as to allow the skull to move more freely. A typical member of this group has an extremely long body with a large, strong arch and spinal canal. The articular processes are well developed. The transverse processes are wide and plate-like. Each spinous process is small. The first cervical vertebra is called the *atlas* and has no body, instead it is modified in the form of a ring. On each side of the anterior edge of the ring is a deep articular cavity for a condyle of the occipital bone of the skull. The posterior edge articulates with the axis. The *axis,* or second cervical vertebra, has a very long body. The anterior extremity presents centrally a projection called the odontoid process. The posterior surface has the usual concave articular surface. The spine is prominent, wide, and thick.

The *thoracic* or *dorsal vertebræ* are usually eighteen in number, sometimes nineteen, rarely seventeen. The body is short and presents laterally two concave facets for articulation with the heads of the ribs. The arch is small. The articular processes are slightly developed; the transverse processes are short and thick, and each has a facet for articulation with the tubercle of a rib; the spinous process is long, and together they determine the contour of the back and withers.

The *lumbar vertebræ* comprise the six bones in the region of the loins. The bodies are longer than those of the dorsal region. The transverse processes are wide, flat plates, resembling an undeveloped rib.

The *sacrum,* or *croup,* is composed of five vertebral segments which are fused so as to form a single bone. It is triangular in form and is wedged between the ilia. Two surfaces, two borders, a base, and an apex are presented for description. The dorsal surface has a crest composed of the partially fused spinous processes. The ventral surface is slightly concave from before backward. The borders are formed by the fusion of the transverse processes and present in front a facet for the articular surface of the ilium. The base is represented by the anterior surface of the first sacral vertebra. The apex is small and articulates with the first coccygeal vertebra.[1]

The *coccygeal vertebræ* comprise all of the movable vertebræ behind the sacrum. They vary in number, depending on the development of the tail, and gradually diminish in size, so that the spinal canal finally becomes a mere groove on the upper surface of the bones.

The **thorax** proper includes only the bones of the ribs and the sternum. It is much compressed laterally in its anterior part, but widens behind.

The **ribs** number eighteen pairs, and are connected at one extremity with the thoracic vertebræ and at the other with the sternum. They are divided into eight pairs of true ribs and ten pairs of false ribs. The *true ribs* articulate directly by means of their cartilages with the sternum, while the *false ribs* articulate by cartilaginous extensions. A *typical rib* is an elongated flat bone with two surfaces and two extremities. The external surface is convex and roughened; the internal, concave and smooth. The dorsal end has three distinct parts, the head, neck, and tubercle. The head is convex for articulation with the two dorsal vertebræ above it. The neck is the constricted part below the head. The tubercle articulates with the transverse process of the corresponding dorsal vertebra. The lower end is enlarged and has a rough cavity for the costal cartilage. The first rib

[1] An observation recorded in Bulletin 117 of the Pennsylvania Agricultural College showed that horses were higher at the withers than at the croup when thin, but after having been "finished" they were higher at the croup.

is the shortest and is nearly straight, the others are more or less curved.

The **sternum,** or **breast bone,** is situated in the ventral part of the chest wall. It is suspended by means of the ribs. There are seven segments or sternebræ which never undergo complete ossification. The upper surface is triangular in shape, narrow in front. The lateral surfaces present seven articular cavities for the cartilages of the true ribs. The inferior border is convex, keel-like, and may be distinctly felt in the living animal. Both extremities are cartilaginous.

BONES OF THE APPENDICULAR SKELETON

The *appendicular skeleton* comprises the bones of the thoracic and pelvic limbs.

A. The *bones of the thoracic* or *fore limb,* named from above downward, are the scapula or shoulder-blade, the humerus or arm, the radius and ulna or forearm, the carpus or knee, the metacarpus or cannon, the first phalanx or large pastern, the second phalanx or small pastern, the third phalanx or coffin bone, the proximal pair of sesamoids, and the distal sesamoid or navicular bone (Fig. 4).

The **scapula** is located on the anterolateral surface of the thorax. In the horse it is connected to the axial skeleton by muscles only (clavicle in man and some other animals). It is directed obliquely downward and forward. The scapula is a flat bone, triangular in shape, presenting for description two surfaces, three borders, and three angles. The external surface is divided into two unequal parts by the spine, a prominent ridge running lengthwise the bone. The narrow fossa in front of the spine is named the supraspinous fossa and the one posterior to the spine the infraspinous fossa. The internal surface is taken up by the subscapular fossa. Above on each side are two rough triangular areas for muscular attachment. The superior border is thick and straight in the young and growing animal, but becomes uneven with age; it gives attachment to the scapular cartilage, the unossified part of the fetal scapula. The anterior border is thin and rough in its upper part, concave and smooth below. The posterior border is thick, concave, and rough. There are three angles to the bone, named respectively anterior, posterior, and articular or humeral. The articular angle carries a glenoid cavity for articulation with the head of the humerus.

The **humerus** is located between the scapula above and the radius and ulna below. It is directed obliquely downward and backward. This bone belongs to the class of long bones and consists of a shaft or body and two extremities. The shaft is twisted in appearance and has four surfaces. The external surface is marked by the musculospiral groove. The internal surface is rounded from side to side and presents above the middle the internal tubercle, and in its lower third the medullary foramen. The anterior surface is flattened, wide above and narrow below. The posterior surface is rounded and smooth. The external border is the only distinct one and shows a large prominence, named the deltoid tuberosity. The proximal extremity is very large and somewhat four sided; it presents a head—an extremely convex articular surface for the glenoid cavity of the scapula. On each side of the head is a tuberosity; in front is a subdivided bicipital groove for the play of the tendon of the biceps muscle. A fossa is located between the head and the bicipital groove, in which are numerous foramina. The distal extremity carries a pulley-like surface for the bones of the forearm; the internal portion of this surface is larger than the external (distinguishing feature). Immediately above and back of this articular surface is the deep olecranon fossa.

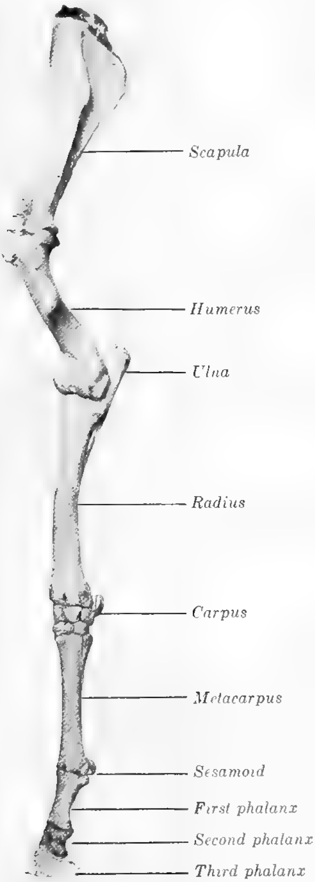

Fig. 4.—Skeleton of left fore limb (lateral view).

The **radius** in the adult horse is united to the ulna to form what appears to be one bone, but in the fetus and young animal there are two distinct bones. The radius is much larger than the ulna. It is a long bone situated between the humerus and the carpus in a nearly vertical direction, and presents for description a shaft and two extremities. The shaft is curved convexly forward, and presents two surfaces and two borders. The anterior surface is convex and smooth, while the posterior surface is concave in its length and flattened transversely. On the external part of the posterior surface there is a rough area for the attachment of the ulna. The borders are rounded, the inner one is not covered by muscles. The upper extremity carries two shallow cavities for articulation with the distal end of the humerus, the inner of which is the larger. Posteriorly are two facets for articulation with the ulna. In front at the inner side is the large bicipital tuberosity, to which the lower tendon of the biceps muscle is inserted. The distal extremity is composed of three facets for articulation with the proximal row of carpal bones.

The **ulna** is a remarkably small bone occupying a position behind the radius and distal part of the humerus. It presents a shaft and two extremities. The shaft is three sided and tapers toward the lower extremity. The anterior surface is attached to the rough area noticeable on the corresponding part of the radius. The internal surface is concave and smooth, while the outer is flattened. The proximal extremity forms the bulk of the bone and projects upward and backward. Its summit is termed the olecranon process and corresponds to the "point of the elbow" in man. The anterior border bears the semilunar notch.

The **bones of the carpus** are either seven or eight in number and arranged in two rows. Named from within outward the upper row is composed of the radial, intermediate, ulnar, and accessory carpal bones; the lower row is made up by the first, second, third, and fourth carpal bones. The first carpal is often absent or the size of a pea. The accessory and the first carpals are not in the line of weight. The carpus, as a whole, has four surfaces. The anterior surface is convex and lies further back than the distal end of the radius, thus affording protection to the joint when the animal falls. The posterior surface is very rough in the macerated state, but is leveled by the thick posterior ligament in the living

animal. The upper and lower surfaces present a number of facets for articulation with the neighboring structures.

The **metacarpus** is composed of the cannon and two splint bones. In most mammals five metacarpal bones are present, but the horse has only the second, third, and fourth Number three, the large metacarpal or cannon bone, is the only one fully developed. The *cannon bone* is one of the strongest bones of the body, and is situated between the carpus above and the large pastern below. It presents for description a shaft and two extremities. The anterior surface of the shaft is smooth and rounded transversely. The posterior surface is rather flat and with the splint bones forms a shallow channel for the suspensory ligament. In the adult sometimes the small bones are firmly united to the cannon, causing the bony enlargement known as "splint." The upper extremity presents several flat facets for the corresponding surface of the carpus, while the lower end has two condyles with a prominent central ridge for articulation with the pastern and two sesamoids. The *splints* are incompletely developed long bones and are three sided. The upper extremity of each is enlarged and articulates with the adjacent bones. The distal extremity is a small nodule which can be easily felt in the living animal by running the hand downward along the cannon, pressing gently with the fingers. This prominence is referred to as "the button of the splint" and is situated from two-thirds to three-fourths the way down the region.

The **first phalanx,** or **large pastern,** is a long bone situated between the cannon and the small pastern in a direction obliquely downward and forward. It forms an angle of 50 to 55 degrees with the horizontal plane in well-formed limbs. The degree of inclination varies considerably in different horses. When the slope is excessive, undue weight is thrown upon the tendons and ligaments at the back of the region; on the other hand, if the bone is too straight, nearly the entire weight of the animal is thrown upon the bones of the foot. The first phalanx presents for description a shaft and two extremities (see Fig. 60). The anterior surface of the shaft is convex, the posterior surface is flattened and roughened. The upper end consists of two shallow cavities for articulation with the large metacarpal bone. The distal end is much smaller and articulates with the small pastern.

The **second phalanx,** or **small pastern,** has a very short shaft.

The bone presents four surfaces. The proximal surface has two shallow cavities for articulation with the distal extremity of the first phalanx. The distal surface is molded for articulation with the coffin and navicular bones. The anterior and posterior surfaces are convex and slightly roughened.

The **third phalanx,** or **coffin bone,** is entirely concealed in the hoof, to which it closely conforms in shape. It presents three surfaces and two angles or wings. The articular surface has two shallow cavities for articulation with the small pastern, behind which is a flat area for the navicular bone. In front is seen the extensor process for attachment of the tendon of the extensor muscle. The anterior or wall surface slopes downward and forward and corresponds to the inner surface of the wall of the hoof; it has a rough, porous appearance due to the large number of foramina which it contains. The inferior surface is clearly divided into two parts by the semilunar crest which gives insertion to the deep flexor tendon. The anterior portion is vaulted, crescent shaped, and is termed "the sole surface," as it corresponds to the horny outer sole. The posterior portion is less extensive and is named "the tendinous surface." The angles or wings project back on either side. The upper edge of each wing gives attachment to a lateral cartilage.

The **lateral cartilages** are two rhombic-shaped masses of cartilage which curve backward toward each other at the heel. The abaxial surface of each is convex; the axial is concave. These cartilages extend above the horny hoof wall and can be easily felt in the living animal. In their natural state they should be flexible. When they undergo ossification, "side-bone" is the result (see Fig. 60).

The **sesamoid bones** are two small bones which articulate with the distal end of the cannon. In their fresh state they are firmly bound together by a disk-shaped mass of cartilage over which the flexor tendons play.

The **navicular bone,** or **distal sesamoid,** is situated back of the coffin bone and lower end of the small pastern. It articulates with both of these phalanges. The deep flexor tendon plays over its posterior surface.

B. The *bones of the pelvic* or *hind limb,* named from above downward, are the os coxæ or hip, the femur or thigh, the tibia and fibula or leg, the patella or stifle, the tarsus or hock, the metatarsus or

cannon, the first phalanx or large pastern, the second phalanx or small pastern, the third phalanx or coffin bone, the proximal pair of sesamoids, and the distal sesamoid or navicular bone.

The **os coxæ** is a large, flat bone which forms part of the lateral wall and the entire ventral wall of the pelvic cavity. The right and left portions come together at the floor of the pelvis; their junction point is known as the symphysis. The three bones forming the os coxæ are the ilium, the ischium, and the pubis. They unite at a cavity named the acetabulum, which forms the articular surface for the head of the femur. A direct joint connects the os coxæ to the axial skeleton.

The **ilium,** the largest of the three bones, is situated on the dorsolateral part of the pelvis and slopes downward and backward. It is triangular in form and composed of a shaft and a wing. The shaft is three sided and joins the other two bones at the acetabulum. The wing presents two surfaces, three borders, and three angles. The dorsal surface is concave; the ventral surface is convex and carries a facet for articulation with the sacrum. All the borders are concave. The internal angle is thick, forms the highest part of this region, and is known as the angle of the croup. The external angle is large and forms the prominence which, in the living animal, is referred to as the "hook bone," point of the hip, or angle of the haunch. The posterior angle is connected with the shaft.

The **ischium** is the most posterior of the bones of the pelvis. It is a flat bone having two surfaces and four borders. Both surfaces are nearly flat. The internal border is thick and rough and is united to its fellow of the opposite side by cartilage. The external border is concave, as is also the anterior, which forms the posterior margin of the obturator foramen. The posterior border is thick and rough. The large, rough tuberosity which projects backward and outward is the "pin bone."

The **pubis** is the smallest of the three and is placed at the anterior part of the floor of the pelvic cavity. Its dorsal surface is smooth, slightly concave, and supports the bladder. The ventral surface is convex and rough. The external angle of the pubis assists in forming the acetabulum. The posterior border forms the anterior boundary of the obturator foramen.

In the living animal the term *pelvic cavity* is applied to the potential cavity which is filled up with the bladder, rectum, and

other soft organs, and lies posterior to the abdominal cavity. In front the pelvic cavity communicates with the abdominal cavity by a large free opening, the inlet. The inlet is a bony circle circumscribed by the sacrum above, the pubic bones below, and the bodies of the ilia on each side. In the mare the pelvic floor is almost level, and is more roomy than that of the male on account of the function it has to perform. The thick, sacrosciatic ligament stretches across each side of the pelvic cavity. This ligament is attached above at the edge of the sacrum and extends to the external borders of the ilium and ischium below. It constitutes much of the lateral wall of the cavity and is strong, yet yielding enough so that under pressure during parturition it assists in making the diameters of the pelvis more even and allows the fetus to pass more easily. The cavity of the pelvis is the space between the inlet and the outlet. During the act of parturition it gives passage to the fetus.

The **femur, or thigh,** is the most massive bone of the body. It is situated between the pelvis above and the tibia below, and slopes downward and forward. It is a long bone presenting a shaft and two extremities. The shaft has four surfaces and two borders. The anterior, internal, and external surfaces are convex, continuous, and smooth. The posterior surface is flattened and triangular in shape. The internal border carries in its upper third the small or internal trochanter, and a little below the middle the medullary foramen. The external border presents the large or external trochanter, below which is the deep supracondyloid fossa. The upper extremity is composed of two parts, the articular head and the great trochanter. The head is a large hemispheric eminence adapted to the acetabular cavity. The great trochanter lies to the outer side of the head and from it the prominent trochanteric ridge descends. The distal extremity is very large and presents a double articular surface, consisting of the two condyles for articulation with the tibia, separated by the intercondyloid fossa, and the trochlea, situated anteriorly, for articulation with the patella.

The **patella, or knee-cap,** has an articular surface to correspond with the trochlea of the femur. This is the bone that is displaced in the condition known as "stifled" in the horse. It is pyramidal in shape with the base upward.

The **tibia** is a long bone situated between the femur and the hock in a direction obliquely downward and backward. It has a

shaft and two extremities. The internal surface of the shaft is straight, not covered with muscle, and corresponds to the shin of man; the external surface curves to the front of the bone, where it becomes flattened; the posterior surface presents several rough

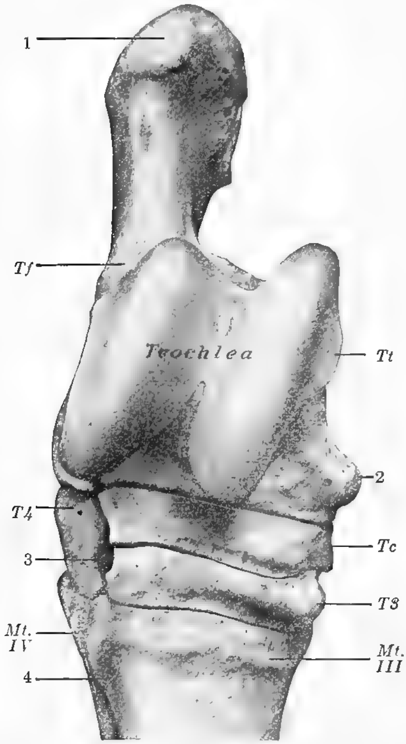

Fig. 5.—Right tarsus and proximal part of metatarsus: *Tt*, Tibial tarsal bone; *Tf*, fibular tarsal; *Tc*, central tarsal; *T3*, third tarsal; *T4*, fourth tarsal; 1, tuber calcis; 2, tuberosity of tibial tarsal; 3, vascular canal; 4, groove for artery; *Mt.III*, *Mt.IV*, metatarsal bones. (Sisson, Anatomy of Domestic Animals.)

ridges and the nutrient foramen. The anterior border is prominent and forms the tibial crest. The upper extremity is large, three sided, and shows two saddle-shaped surfaces for articulation with the condyles of the femur; centrally there is a pointed prominence; externally there is a rough facet for the head of the fibula.

The distal extremity carries an articular surface composed of two deep furrows with a ridge between for the tibial tarsal bone.

The **fibula** is a reduced long bone situated along the outer border of the tibia, with which it articulates at the proximal extremity. The distal extremity ends as bone about the lower third of the tibia, but is continued by a fibrous cord to the distal end of the tibia.

The **tarsus,** or **hock,** is composed of a collection of short bones situated between the tibia and the metatarsus (Fig. 5). There are six or seven bones in the group, arranged in two rows, with a central bone between. The upper row contains the tibial and fibular tarsal bones, below which lies the central. The lower row is made up of the fused first and second, third, and fourth tarsal bones.[1] The fibular tarsal is the largest of the bones of the tarsus and consists of a body which is provided with facets for articulation with the adjoining bones. Projecting upward and backward from the body is a prominence which corresponds to the heel of man. In the horse it forms the point of the hock (tuber calcis). The tibial tarsal is the inner bone of the upper row. Its superior and anterior surfaces are continuous and present two ridges, with a furrow between, which are directed obliquely forward and outward for articulation above with the distal end of the tibia. The central tarsal is situated between the two rows. The first and second are usually united to form a single bone. The third is somewhat like the central in form and appearance. The fourth is cubical in shape.

The **metatarsus** is composed, like the corresponding region in the fore limb, of the cannon and two splint bones. These bones are directed downward and a little forward. The hind cannon is about one-sixth longer than that of the fore limb; in a medium-sized animal the difference is about 2 inches. On cross-section it is more nearly circular in outline. The splints are larger and stronger, the external being relatively massive.

The **digit** of the hind limb is similar to that of the fore. The principal differential features lie in the third phalanx, which has a less oblique wall, a narrower toe, and a sole surface that is more concave. The distance between the angles or wings is less than in the fore coffin bone.

[1] These names apply when viewing the hock from the front and from within outward.

Variations in Horses' Toes.—A single-toed mare has given birth to a foal which had an extra toe on each foot. This peculiarity is known as polydactylism and may be hereditary. This condition is often cited as an instance of reversion. There is, however, no reason to believe that this is different in type from cases of polydactylism in other animals. The occurrence of super-

Fig. 6.—Polydactylism or supernumerary digits. The abnormality involves both of the carpal joints.

numerary digits is not infrequent in man and is quite common in cats. The illustration (Fig. 6) is that of a horse exhibited as a freak at the Wisconsin State Fair in 1913.

The metacarpal and digital regions of the horse afford the best example of changes due to evolution. The earliest existing horse skeleton, recognized

beyond a question as such, shows four complete toes and a splint of a fifth. The hind foot has three toes and a splint. These horses were about the size of a fox terrier dog and known as "dawn horses." From this period the horse gradually increased in height, the number of toes became reduced from four to one on each limb, while the teeth increased in length and hardness with the change in the character of the food.

JOINTS

A *joint* is the union of two or more bones or cartilages. Joints are classified, according to structure, into three types:

Type I, immovable, in which the opposed surfaces are directly united by connective tissue, *e. g.*, joints between the bones of the skull. The periosteum also assists in this union.

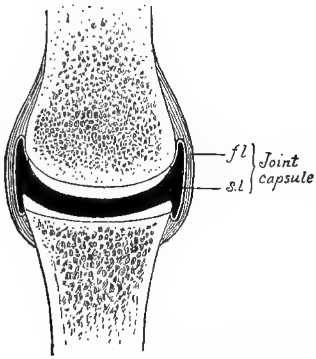

Fig. 7.—Diagram of section of true joint: *f.l.*, Fibrous layer; *s.l.*, synovial layer of joint capsule. The articular cartilages are white, bones dotted, and joint cavity black in the figure. (Sisson, Anatomy of Domestic Animals.)

Type II, slightly movable, in which the bones are united by cartilage that is elastic enough to permit a slight movement, *e. g.*, the intervertebral joints.

Type III, freely movable, in which a joint cavity exists between the opposed surfaces, *e. g.*, hinge-joint, as that of the elbow; and ball-and-socket joint, as that between the pelvis and the femur at the hip.

The **freely movable joints** are the only true joints (Fig. 7). They have the following structures entering into their formation:

1. Two or more bones the joint surfaces of which are usually somewhat expanded.

2. The articular cartilages which cover the articular surfaces of the bones. They are exceedingly smooth and are thickest on the central part of a convex surface, while on a concave surface the marginal cartilage is thickest. These cartilages diminish the effects of concussion and greatly reduce friction.

3. The joint capsule is a sort of sac, the margins of which are attached around the articulating surfaces. It is composed of two layers—an external, strong fibrous layer, and an internal synovial layer, which secretes the synovia or "joint-oil" to lubricate the joint.

4. The ligaments are strong fibrous bands which come down on each side outside the joint capsule and bind the bones firmly together. They are pliable, but inelastic, and maintain the articular surfaces in more or less close contact and thus greatly strengthen the joint.

The **joint cavity** is a potential cavity and does not actually exist in the sense of a space occupied by air. When the bones of the articulation are forcibly pulled apart there may be a small space, but it is largely filled with the synovia.

Movements of True Joints.—As a class the freely movable joints have a variety of movements. When considered separately, joints of this type are found to vary greatly in their possibilities for movement. There are seven principal kinds of joint movements:

1. Gliding, the simplest and only movement possible between two plane or undulating facets.
2. Flexion, which brings two bony pieces nearer each other by closing the angle more or less.
3. Extension, the inverse movement by which the bones are straightened on each other.
4. Adduction, which brings the inferior end of the movable bone toward the median plane of the body.
5. Abduction, where it has the opposite effect.
6. Circumduction, in which the shaft of the distal bone of the joint describes the surface of a cone.
7. Rotation, in which one bone pivots or rotates on the other.

From a practical standpoint, the shoulder, fetlock, pastern, and coffin joints of the fore leg, and the hip, stifle, and hock joints of the hind leg are the most important. We have already learned about the shape of the articular surfaces of the bones which enter into

these joints. Furthermore, it has been stated that these surfaces in the living animal are covered with a layer of cartilage. In addition to these articular cartilages, in some joints an accessory cartilage is found which plays an important part in the work of the joints. At the hip-joint this arrangement is seen in the form of a marginal ring of fibrocartilage, which very appreciably deepens the acetabulum and makes dislocation extremely difficult if not impossible.

The **stifle-joint,** which corresponds to the knee-joint of man, is the largest and most elaborate of all the articulations. This is because it comprises two joints, the femoropatellar and the femorotibial. Two **C**-shaped cartilages are placed between the femur and tibia to adapt them more properly to each other (see Fig. 61).

Synovia is a viscid, straw-colored fluid which gives an alkaline reaction. It contains proteins, salts, and mucin. The latter gives synovia its viscidity and lubricating property. The amount of synovia increases and diminishes to a certain extent under normal conditions. When an excessive quantity is present a puffy swelling occurs in the region of the joint. Bog spavin is a good example of an excess in the hock-joint.

CHAPTER III

THE MUSCULAR SYSTEM

The *muscles* of the body comprise the flesh or lean meat and the muscular part of the walls of the stomach, intestines, and other

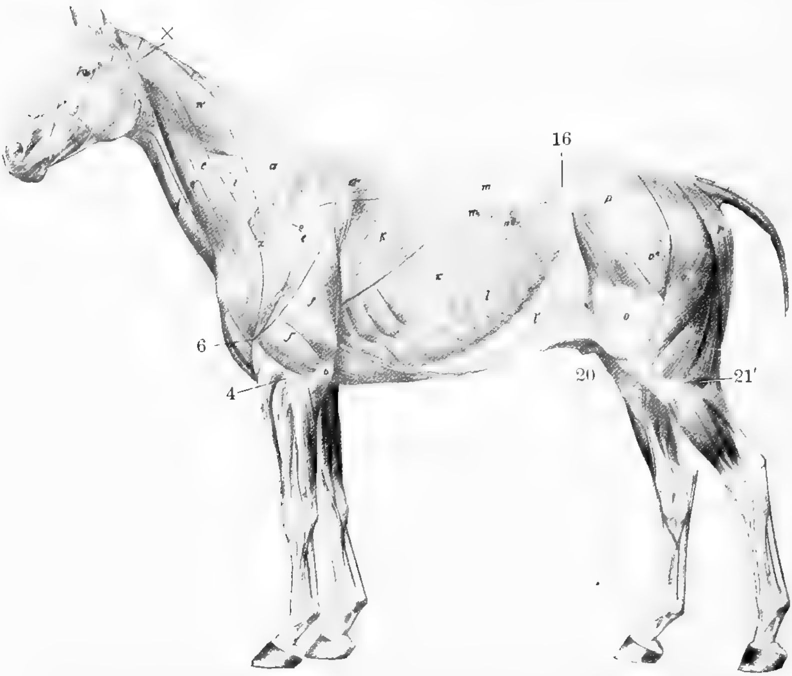

Fig. 8.—Superficial layer of muscles: ×, Wing of Atlas; 2, spine of scapula; 4, condyle of humerus; 6, deltoid tuberosity; 8, olecranon; 16, external angle of ilium; 20, patella; 21′, lateral condyle of tibia. (Ellenberger-Baum, Anat. für Künstler.)

soft organs. The muscular system is the largest of all the body systems, the skeletal muscles alone representing 45 per cent. of the

body weight (Fig. 8). Muscle tissue is responsible for all movements or work, both voluntary, like walking and jumping, and involuntary, like the circulation of the blood and movements in all the other internal organs. Since they must be active both night and day, muscles are classed with the nerves as the master tissues of the body.

There are two kinds of muscles: (1) voluntary or striped, and (2) involuntary, unstriped or smooth.

VOLUNTARY MUSCLES

The **voluntary muscles** are under the control of the will. They are often referred to as skeletal muscles, for they act on the bony levers. In general, their color in the horse is dark red or even brown. When exposed to the air they acquire a bluish luster. There is a wide difference in the volume or size of voluntary muscles: some are very strong and powerful, like those of the thigh, while others are short, delicate strands, capable of doing but little work. The form varies with the work to be performed by the muscle. The usual forms are long, short, and ring-like. Depending on shape, voluntary muscles are classified into simple and digastric; biceps, triceps, and quadriceps; penniform and semipenniform. The structure of voluntary muscles is seen upon microscopic examination to be bundles of extremely delicate fibers which are striped horizontally. Each fiber has a delicate covering membrane, the sarcolemma. Bundles of fibers are held together by the perimysium, which is composed of bands of white fibrous tissue. When much strain is placed on a muscle, tendinous fibers are mixed with the fleshy fibers. Blood-vessels and nerves are plentifully distributed throughout the musculature (Fig. 9). Fresh horse meat possesses a peculiar, sweet, somewhat disagreeable odor.

Tendons are round or flattened cords fitted to the extremities of long muscles. Flat muscles have widened tendons, named aponeuroses, for attachment. A tendon is usually less extensive than the fleshy portion of the muscle; this permits many muscle attachments to a relatively small surface. In the horse's legs are found "check ligaments," more properly called tendons, which take the strain off the muscles of the limbs and allow the animal to sleep in the standing position without undue fatigue.

The *attachments* of a muscle determine its extent, direction,

relation, and uses. Each muscle has at least two attachments, known as origin and insertion. The origin is the point which usually remains fixed while the muscle contracts. The insertion or termination is the point which is fixed to the bone that is displaced by the muscular contraction. This is not a hard-and-fast rule, for the action may be reversed and the insertion become the origin, as is the case when the head and neck are inclined to one side by the contraction of the mastoido-humeralis. Muscles are arranged in groups that oppose each other when they act on the

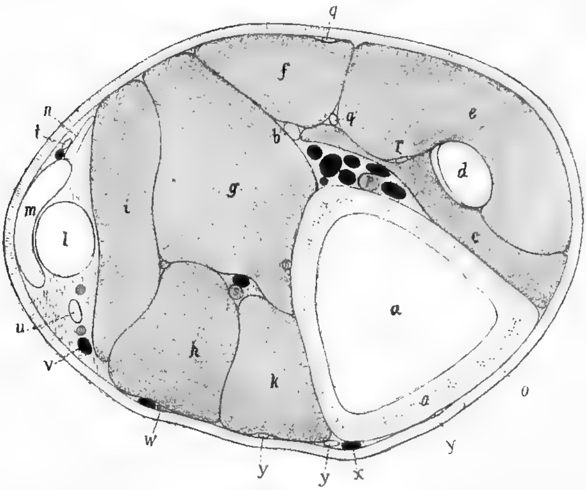

Fig. 9.—Cross-section of left leg, cut a little above middle: *a*, Tibia; *b*, fibula; *d*, *l*, *m*, tendons of muscles; *c*, *e*, *f*, *g*, *h*, *i*, *k*, *n*, fleshy portions of muscles; *o*, skin; *p*, *s*, *w*, arteries; *v*, *x*, veins; *q*, *q'*, *r*, *t*, *u*, *y*, nerves. (Ellenberger in Leisering's Atlas.)

joints, one group acting as flexors and the antagonistic group as extensors.

To facilitate the play of a muscle or tendon over bony prominences are bursæ and tendon sheaths. **Bursæ** are small sacs filled with a fluid which resembles synovia. They form pads to prevent friction. The **tendon sheaths** are elongated, closed sacs containing serous fluid. They are folded completely around the tendons, as the diagram (Fig. 10) shows.

Each skeletal muscle has a name. Names of muscles have

been handed down from the earlier anatomists, who gave them in a haphazard manner. Some were based on form, location, and function; others have been adopted from human anatomy and do not apply to quadrupeds, so there has been little uniformity in muscle terminology.

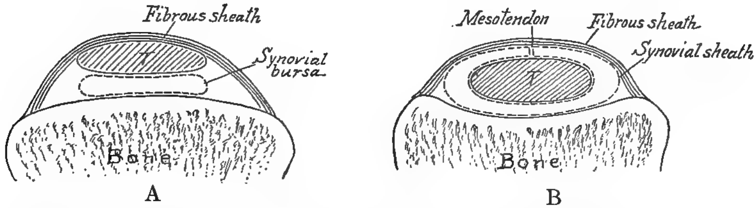

Fig. 10.—Diagram of cross-section of bursa (A) and tendon sheath (B): *T*, Tendon. For the sake of clearness the synovial sacs are represented as somewhat distended. (Sisson, Anatomy of Domestic Animals.)

In the following classification of the chief muscles of the fore limb, which is given to illustrate the general arrangement of muscles, the names are those given preference in Sisson's "Anatomy of Domestic Animals":

Flexor Muscles of the Elbow:
1. Biceps brachii.
2. Brachialis.

Extensor Muscles of the Elbow:
1. Tensor fasciæ antibrachii.
2. Triceps brachii.
3. Anconeus.

Flexor Muscles of the Carpus:
1. Flexor carpi radialis.
2. Flexor carpi ulnaris.
3. Ulnaris lateralis.

Extensor Muscles of the Carpus:
1. Extensor carpi radialis.
2. Extensor carpi obliquus.

Flexor Muscles of the Digit:
1. Superficial digital flexor.
2. Deep digital flexor.

Extensor Muscles of the Digit:
1. Common digital extensor.
2. Lateral digital extensor.

In addition to these muscles of the fore limb, attention is called particularly to the heavy muscles of the haunch and thigh, where the propelling power of the horse lies. Notice is also directed to the relation between the development of these muscles and the conformation of the animal's body.[1]

[1] Agricultural students whose time is limited need not be required to describe each muscle in detail. Those who wish to go into the subject more fully are referred to text-books on veterinary anatomy.

CHEMISTRY AND PHYSIOLOGY OF MUSCLES

A *chemical analysis* of fresh muscle-fiber shows that approximately 75 per cent. of it is water. The balance of the constituents are principally proteins, carbohydrates and fats, nitrogenous waste products, and inorganic salts. *Muscle proteins*, which make up the largest part of the organic constituents, are myosinogen, myoglobulin, myostromin, and collagen. The *carbohydrates* are in the form of sugar and animal starch or glycogen. Muscular tissue has the power to convert glucose into glycogen, which is stored in the muscle until required for use during muscular activity. It has been clearly demonstrated that long-continued activity causes the glycogen to completely disappear. *Fat* is present in small quantities in the fibers. The *nitrogenous extractives* are of various kinds; the one present in greatest amount is creatin. The *inorganic constituents* of muscle are chiefly salts of potassium, sodium, calcium, magnesium, and iron, the former predominating.

Irritability and Contractility.—Muscles possess both of these powers in well-developed form. Irritability is a sensitiveness to stimulation, and is an attribute of all living tissues. Contractility is normally due to a stimulus received from the central nervous system through motor nerves. If the latter are severed, the muscles are paralyzed. The skeletal muscles are, however, capable of independent contraction. Contraction as a result of thermal stimulation is seen when an animal is butchered—the cold air coming in contact with the recently exposed flesh sets up a pronounced twitching in the muscles. When a muscle contracts it shortens in length and increases in width. A contracted muscle soon relaxes. This is due largely to the action of antagonistic muscles.

The means used to make a muscle contract for experimental study are: (1) chemical agents, like dilute mineral acids and metallic salts; (3) mechanical stimuli, like striking, pinching, or tearing the muscle; (3) thermic changes brought about by the application of heat or cold; (4) electric stimulation from the use of the galvanic battery or an induction coil. The duration, curve, and strength of contraction may be demonstrated by applying these stimuli under properly controlled conditions.

The **chief functions of muscles** are to produce heat and to perform work. Heat is created in greater amount by increasing

the activity of the muscle. It is measured in calories by a specially constructed apparatus, termed the "calorimeter." Work is a result of muscular activity. It is also accurately estimated by delicately controlled instruments. Locomotion and the pulling of a load are examples of direct work. Indirect work is seen in the modifications of the visceral organs. About two-thirds of the energy liberated when a muscle contracts is in the form of heat, the other one-third may be applied as external work.

The living animal requires fuel material to generate heat and perform work. This is furnished by the combustion of the nutrients digested from the hay and grain which it consumes. The transformation of stored energy into heat and work in the animal body takes place according to the same general laws of chemistry which govern the generation of these powers in artificial motors like steam and gasoline engines. A muscle supplied with fuel produces about $66\frac{2}{3}$ per cent. of the heat which the same material would produce when burned. The balance, or $33\frac{1}{3}$ per cent., is converted into work. Many factors influence the proportion of energy produced, but it follows the great law of conservation of energy in nature. The body neither manufactures nor destroys energy. All that it produces is derived from its food.

Fatigue of the muscle follows continued work. This is either due to the fact that the products of activity, principally sarcolactic acid, accumulate in the muscle, or to the using up of substances from which energy is derived. The latter results in the condition termed "exhaustion." As soon as the accumulated waste products are removed by the blood and lymph, and a fresh supply of nutrients is brought to the organ, there is a rapid renewal of irritability and contractility and a feeling of "fitness" prevails.

Hand-rubbing the legs of horses is beneficial because the blood- and lymph-vessels are stimulated to increased activity in the removal of waste products, and in causing the blood to circulate more freely. Fatigue may be in part overcome by providing a feed of readily available carbohydrates which are convertible into glucose, in which form they may be at once utilized by the cells of the body for nutritive purposes.

Experimentally, the course of fatigue in a muscle may be studied by causing an isolated muscle to contract to its limit, at regular intervals, against the resistance of a spring. The length of the successive contractions is recorded on the smoked surface of a

slowly revolving cylinder. A fatigue tracing of this kind shows that continuous work by a muscle removed from the body and, therefore, not supplied with blood, finally results in the muscle's refusal to respond to stimulation. On the other hand, if a similar tracing is taken from a muscle with its circulation intact, a fatigue level of working power will be found. This proves that the blood furnishes substances to maintain the working power of muscles.

A "green" horse—that is, one not accustomed to steady work—fatigues much easier than a "hardened" horse, because his muscles are softer and carry an excess of fat. By working such a horse moderately, with properly spaced periods of rest, it is possible to build up the muscle cells so that he can do as much work as the "seasoned" animal. It should be remembered that there is a limit to continued muscular effort, and that harmful fatigue can be avoided only by working the horse at a moderate rate, so as to keep a balance between the products of muscle activity and the ability of the blood to remove this waste material. An animal should under no circumstances be worked until exhausted, if for no other reason than that it is not economical.

Rigor mortis is the condition of stiffness which the muscles usually assume soon after death. It is probably due to the coagulation of certain muscle proteins through the formation of sarcolactic acid and myosin. The muscles of the head are first affected. From here the change rapidly spreads backward to the body muscles. The time when rigor mortis appears depends upon the activity of the muscles just before death; the greater this has been, the sooner rigor sets in and the longer it lasts. Animals which have died from exhaustion or severe febrile disease show little rigor mortis; it appears very soon and passes off quickly. In such cases decomposition changes set in almost immediately as the bacteria present in the body find conditions suitable for their rapid growth and multiplication. When rigor mortis disappears the muscles become soft and the body becomes limp.

INVOLUNTARY MUSCLES

Involuntary muscles are smooth or unstriped. They occur in the walls of all the hollow organs of the body, such as the stomach, intestines, bronchi, bladder, arteries, and veins. Because they are found almost exclusively in soft organs they are known as visceral muscles. In structure they differ from the voluntary muscles

in being composed of relatively minute, spindle-shaped cells, each with a single nucleus (see Fig. 1). The nerve supply comes in most cases directly from the sympathetic system instead of the central nervous system, as is the case with the voluntary muscles, so the contractions are not under the direct control of the will. All movements of internal organs—that is, those having to do with the vegetative life of the body—are governed by these muscles. They are, therefore, more important than the voluntary muscles, for life would cease at once if the visceral organs failed to act.

The **heart muscle** is between the voluntary and involuntary muscles in both structure and physiologic properties. Although it is not directly under the control of the will, it is composed of muscle-fibers striated or striped in a peculiar fashion. It contracts slower than voluntary, but faster than smooth muscle tissue. The power of rhythmic contractility is developed to a wonderful degree in heart muscle.

CHAPTER IV

THE DIGESTIVE SYSTEM

THE *digestive system* is made up of a tube about 100 feet long, looped on itself many times, dilated at intervals along its course, and provided with several accessory organs. The anterior opening is for the reception of food; the posterior, for the expulsion of the unabsorbed portion and wastes.

The entire canal is lined with **mucous membrane**—a moist, velvet-like tissue with an inner or free surface—usually thrown up into folds. These folds become effaced with the distention of the walls of the organs with food or gas. At the natural body openings it is continuous with the skin. The character of the mucous membranes varies in different organs, depending on the functions which it has to perform.

External to the mucous lining is found a double layer of involuntary muscle-fibers, composed of an inner circular and an outer longitudinal layer. Through the alternate wave-like contraction and relaxation of these muscle-fibers the food is thoroughly mixed with the digestive juices, and conveyed along the canal from organ to organ.

In the greater part of its course the canal receives another covering in the form of a **serous membrane.** This is a thin, transparent, shiny, and smooth tissue which is reflected from the walls of the body cavities. It serves as a covering for the soft organs in these cavities and acts as a lining for their walls. Its free face is always in contact with itself. From it is secreted a serous fluid that keeps the membrane moist and allows the viscera to glide freely upon each other. Serous membranes are very sensitive to infection, for they rapidly absorb fluids. They are never so placed as to come in contact with the external air.

The **peritoneum** is the name given to the serous lining of the *abdominal cavity*. The most satisfactory way to understand the general disposition of it is to think of the cavity as empty and lined by a single layer of peritoneum (Fig. 11). The organs may be regarded as beginning to develop outside this membrane, and, as they enlarge, gradually push into it and become enveloped by it.

This causes folds of the peritoneum to connect the organs with the wall or with each other. The connecting folds are termed *omenta*, *mesenteries*, and *ligaments*. They contain fat in varying quantities, depending upon the condition of the animal, and furnish a

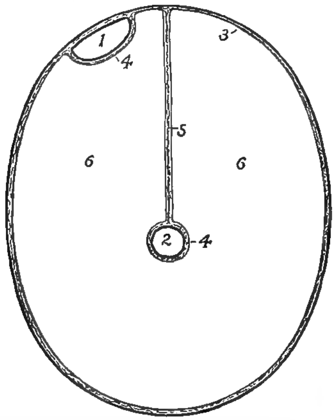

Fig. 11.—Diagrammatic cross-section of abdomen to show arrangement of peritoneum when reduced to its simplest form. The external black line represents the body wall: 1, Organ (*e. g.*, kidney) in contact with wall; 2, organ (*e. g.*, small intestine) at a distance from wall; 3, parietal peritoneum; 4, visceral peritoneum; 5, mesentery; 6, peritoneal cavity. (Sisson, Anatomy of Domestic Animals.)

path for the vessels and nerves of the viscera. The principal mesenteric folds are the **great omentum,** the large lace-like membrane behind the stomach, and the **great mesentery,** which suspends the small intestine from the roof of the abdominal cavity.

THE ORGANS OF DIGESTION

The organs of digestion may be conveniently grouped[1] into—

(*A*) *Alimentary Organs:*

1. Mouth.
2. Pharynx.
3. Esophagus.
4. Stomach.
5. Small intestine.
6. Large intestine.

(*B*) *Accessory Organs:*

1. Tongue.
2. Teeth.
3. Salivary glands.
4. Liver.
5. Pancreas.
6. Intestinal glands.

[1] These groups do not include all the structures usually described and recognized as separate organs. Structures not included will be taken up in their proper places when each of the above organs is described.

The **mouth** is a cylindric cavity situated between the two jaws, elongated in the direction of the long axis of the head. It has an anterior opening for the introduction of food, and a posterior one to communicate with the pharynx. When closed, the mouth is nearly filled up by the teeth and tongue.

The **lips** are designated *superior* and *inferior* from their positions. On the outer surface of the lips are found many fine, short hairs; also a number of long bristle-like hairs of a tactile nature. The inner surface is lined with mucous membrane, which is smooth and usually of a pink color. The function of the lips is the prehension of foods. They also assist in keeping the food in the mouth during mastication. If the nerves supplying the lips are cut or severely injured, paralysis results and the horse cannot graze.

The **cheeks** are two smooth membranous walls which form the sides of the mouth. They are continuous in front with the lips; above and below, with the gums. They are very active agents in the mastication of food, and constantly push the food between the teeth. Numerous secreting glands are found in the cheeks.

The **tongue** extends from the back part of the mouth to the incisor teeth. It is a freely movable muscular organ. Some of its muscles are directed longitudinally, others vertically, and still others transversely. This arrangement affords the organ extensive movement in all directions. For description, it may be divided into tip, body, and root. The tip is free and can be extruded from the mouth. The body is the main part, and is covered superiorly with fine, file-like elevations, termed "papillæ." Near the back part of the tongue there are two large circumvallate papillæ in which the taste-buds are found. The root is inserted into the lingual process of the hyoid bone. The function of the tongue is the prehension of liquids. It also assists in mastication by keeping the food between the teeth. During the act of swallowing it performs the important duty of a piston, and moves back and forth with each swallow of fluid.

The **teeth** are classified according to form and position into: *Incisors*, situated in front, implanted in the premaxillæ and the body of the mandible; *canines*, situated a little further back, nearer the incisors in the lower jaw than in the upper; *molars*, which occupy the side of the dental arch and are often termed "the grinders" (Fig.

12). Since the teeth of the two sides are alike, the dental formula has been used as a short method of indicating the number and

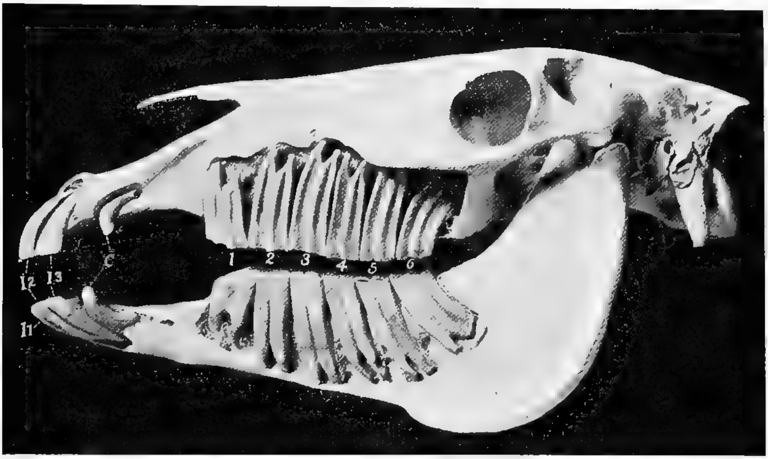

Fig. 12.—Skull of adult sculptured to show embedded parts of teeth: I_1, I_2, I_3, Incisors; C, canines; 1, 2, 3, 4, 5, 6, molar teeth numbered without reference to the first premolar, which is not present in this specimen. (Sisson, Anatomy of Domestic Animals.)

kind of teeth an animal has. It is represented for adult male horses in the following manner:

$$2\left(I\frac{3}{3}+C\frac{1}{1}+PM\frac{3 \text{ or } 4}{3}+M\frac{3}{3}\right)=40 \text{ or } 42.$$

In this formula the letters indicate the kinds of teeth, and the figures above and below the line give the number of teeth of one side in the upper and lower jaw respectively.

This formula varies from the fact that the *wolf teeth* may or may not be present. These teeth are classified as upper premolars, but in some subjects occur in the lower jaw. There is still a controversy as to whether they belong to the permanent or temporary set. The presence of wolf teeth neither does harm nor causes eye disease or weakness.

The canine teeth of mares are usually so small that they do not erupt. In 8000 subjects examined by Ellenberger, between

2 and 3 per cent. had visible canines in each jaw; 6 to 7 per cent. had them in the upper jaw; while 20 to 30 per cent. had them in the lower jaw.

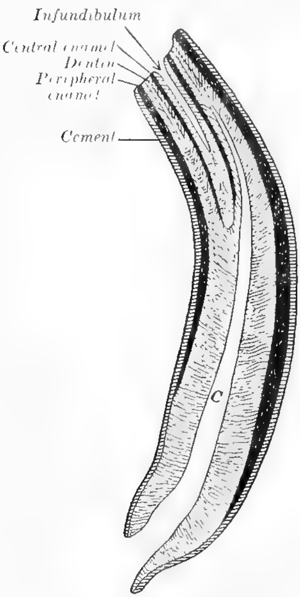

Fig. 13.—Longitudinal section of lower incisor teeth: *C*, Pulp cavity. Cement is shown in the infundibulum, but is not marked. (Sisson, Anatomy of Domestic Animals.)

Anatomically, an incisor tooth is divided into the crown, neck, root, infundibulum, and cup. The *crown* refers to the projecting portion or that part that is visible. The *neck* is the part covered with the gum. The *root* is the portion that is embedded in the jaw bone. The *infundibulum* is the cavity on the table surface produced by the infolding of the enamel. The *cup* refers to the unfilled portion of the infundibulum of an incisor tooth.

Teeth are composed of dentin, which is capped with enamel and encrusted over the remaining portion with cement (Figs. 13, 14). The *dentin* is dense in consistency, yellowish-white in color, and forms the bulk of most teeth. The *enamel* forms a thin cap over the dentin of the crown. In herbivora it is folded into the table surface. In the virgin tooth it covers the entire table surface, but soon wears off on the grinding portion, leaving only projecting edges. Enamel is a secretion of epithelial cells and

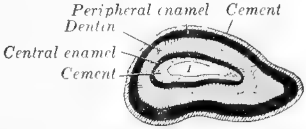

Fig. 14.—Cross-section of lower incisor tooth: *I*, Infundibulum. (Sisson, Anatomy of Domestic Animals.)

cannot be reproduced when it is once destroyed. The *cement* is the external covering of the root. In complex teeth, like those of

the horse, it fills in spaces between the enamel folds of the crown also.

Horses have two sets of teeth, known respectively as the temporary teeth, which are smaller, softer, and whiter than the permanent teeth. The formula for the temporary or deciduous teeth of both males and females is—

$$2\left(\mathrm{Di}\frac{3}{3}+\mathrm{Dc}\frac{0}{0}+\mathrm{Dm}\frac{3}{3}\right)=24.$$

A foal is usually born with the two central incisors and all the deciduous molars erupted. At four to six weeks the lateral incisors appear above and below. When eight to ten months old the corner

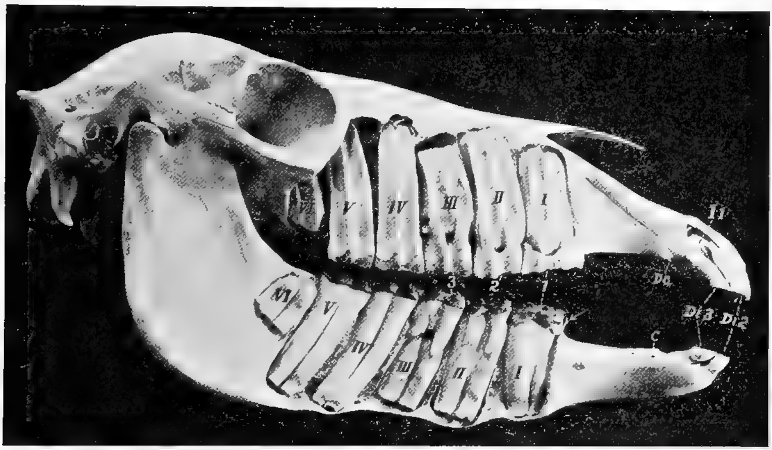

Fig. 15.—Skull of two-year-old colt, sculptured to show embedded parts of temporary and permanent teeth. The upper first premolar (wolf tooth) is present, but not visible; the lower one is indicated by the arrow. Temporary premolars are numbered 1, 2, 3; permanent premolars are designated by Roman numerals; *Dc*, upper temporary canine; *C*, lower permanent canine, which was not ready to erupt; *Di*2, *Di*3, second and third temporary incisors; I_1, first permanent incisor, not quite ready to erupt. (Sisson, Anatomy of Domestic Animals.)

incisors come in. The fourth or first permanent molar appears at one year, and from two to two and one-half years the fifth molar should be in wear. The sixth is the last to erupt, and may not show until the fourth or fifth year. As soon as the temporary

teeth erupt two influences are at work to destroy them—the permanent teeth are gradually encroaching on their roots, while the crown is becoming shorter and shorter under the influence of wear,

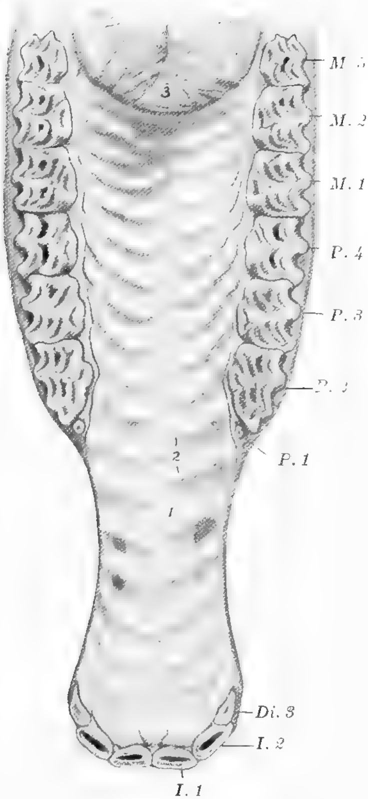

Fig. 16.—Upper teeth, hard palate, and adjacent part of soft palate: I.*1*, First incisor; I.*2*, second incisor; Di.*3*, deciduous third incisor; P.*1*, "wolf tooth" or first premolar; P.*2*-*4*, premolars; M.*1*-*3*, molars; 1, groove of palate; 2, ridges of palate; 3, soft palate. (Sisson, Anatomy of Domestic Animals.)

until at the age of two and one-half years there remains only a loosened shell.

To determine the age of a horse the time of eruption and wear of the teeth are used as guides. In young horses the permanent

incisors have a crown which is broad transversely; later in life the two diameters are about equal; in extreme age the antero-posterior diameter may greatly exceed the transverse. The angle at which the upper and lower incisors meet becomes rapidly less as age advances. The cup of an incisor tooth disappears about three years after the tooth erupts, and the infundibulum from ten to fifteen years after. Both central incisors in the lower jaw lose their cups when the horse is about six years of age, the laterals at seven, and the corners at eight. At nine years the cups in the upper central incisors disappear. At ten years a yellowish-brown groove appears at the top of the upper corner incisors, and reaches the wearing surface when the horse is twenty-one years old. The infundibulum gradually becomes smaller, nearer the lingual border, and finally disappears. It remains longer in the upper than the lower incisors because of its greater depth; therefore the latter should be observed when determining the age of a horse.

The **salivary glands** occur in pairs. They are named the parotid, the submaxillary, and the sublingual. The *parotid gland* is the largest and is located in front of the wing of the atlas, behind the upright portion of the jaw and below the base of the ear. Its length is about 10 inches and thickness nearly 1 inch. Its secretory duct leads from the anterior lower corner of the gland forward and downward, along the inside of the mandible, then it turns outward, around the inferior margin of the jaw, finds its way across the face, and finally ends by piercing the cheek opposite the third upper cheek tooth. The *submaxillary gland* lies internal to the parotid in the submaxillary space. It is about 10 inches long and is curved with the concavity forward. The submaxillary duct is formed by the union of small radicles, and runs forward from the concave border along the floor of the mouth. It empties beneath the tongue opposite the canine tooth. This opening is plainly seen in the living animal, and is commonly referred to as the "barb." The *sublingual gland* is placed between the tongue and the horizontal part of the mandible. There are about thirty sublingual ducts, which open in a row on each side of the floor of the mouth. The function of the salivary glands is to secrete saliva. It has been estimated that the horse secretes from 72 to 84 pounds of saliva in twenty-four hours. This is nearly ten times as much as the volume of urine voided in a day. An excessive flow of saliva causes *slobbering* or *drooling*. It may be

due to poisoning from mercury, to a foreign body lodged in the mouth, or to bad teeth. When horses are first turned into white clover pasture increased salivation also often occurs.

The **hard palate** is bounded in front and on each side by the teeth, behind it is continuous with the soft palate (see Fig. 16). On its surface is a median groove dividing it into two equal parts. Twenty curved alternating grooves and ridges run across each half; the concavity of these is backward. The ridges aid in retaining the food when it is carried toward the back part of the mouth. Swelling of the hard palate, sometimes noticeable in colts which are teething, is commonly spoken of as "lampers," more correctly, *lampas*. It is not a serious disease, and disappears when the irritation subsides.

The **soft palate** is a semimuscular organ suspended like a curtain between the mouth and pharynx. It slopes downward and backward from its junction with the hard palate. It presents two surfaces and four borders, and is 5 or 6 inches long. The anterior surface is toward the mouth, and the posterior toward the pharynx, the anterior wall of which it forms. The lateral borders are attached to the walls of the two cavities which the organ separates. The superior border joins the hard palate, while the inferior is free and in contact with the epiglottis, which may lie either in front or behind the soft palate. Mucous membrane covers both sides of the organ. During the act of swallowing it is raised to allow the food to pass through. On account of its length in the horse it is practically impossible for the animal to vomit through the mouth. Instead, the material is passed along the posterior surface of the soft palate and finds exit via the nasal cavity and nostrils. This also explains why breathing does not take place through the mouth.

The **isthmus of the fauces** is the opening between the mouth and the pharynx. Normally it is closed by the soft palate except during deglutition. In man the tonsils are situated on the lateral walls of this opening; in the horse the tonsillar tissue is distributed over a larger area.

The **pharynx** is a common organ of the digestive and respiratory tracts. It is funnel shaped and is situated as a cross-roads between the nasal chambers and the larynx and the mouth and the esophagus. Its walls are lined with mucous membrane, outside of which are voluntary muscles. There are seven openings

in the pharynx—viz.: (1, 2) the posterior nares, which communicate with the nasal chambers; (3) the mouth orifice; (4) the esophagus; (5) the larynx; (6, 7) the eustachian tubes, slit-like openings situated high up on the lateral walls of the pharynx. The latter have a cartilaginous flap which closes during swallowing.

The **esophagus** is a fibromuscular tube which connects the pharynx with the stomach. It is about $4\frac{1}{2}$ feet long and runs down the left side of the neck. Upon reaching the thorax it assumes a median position, passes between the two lungs, pierces the diaphragm, and at once enters the stomach. The lining membrane is always thrown up in folds except during the act of swallowing.

The Mechanism of Swallowing.—Direct observations made by Sisson show that when the horse swallows the following movements occur: The soft palate is shortened and is raised so as to close the openings into the nasal cavity. The pharynx is shortened and its end toward the mouth is dilated. The root of the tongue and the larynx are brought toward each other, so that the epiglottis touches the former. The arytenoid cartilages of the larynx are approximated and the glottis is closed, thus preventing aspiration of food particles. The bolus of food is "shot," so to speak, through the pharynx by an energetic contraction of the muscles which raise the tongue. This is followed by a so-called "clearing up" phase, in which remnants which remain are removed from the pharynx by the constrictor muscles of that organ. The first stage of deglutition is voluntary, but the rest of the act is not under the control of the will.

The **stomach** is a U-shaped sac placed between the esophagus and intestines (Fig. 17). It has a capacity of 2 to 4 gallons. The *inlet* or *cardia* and the *outlet* or *pylorus* are close together. It is situated in the abdominal cavity opposite the fourteenth to sixteenth ribs, behind the diaphragm and liver, and above the large colon, so it does not come in contact with the walls of the cavity. The stomach is held in position mainly by the pressure of the surrounding organs and by the esophagus. Like other viscera in the abdominal cavity, it has three layers to the wall—the mucous, the muscular, and the serous. The mucous layer is clearly divided into two parts (Fig. 18). That which lies to the left contains no glands, is similar to the lining of the esophagus, and is covered with thick, stratified epithelium. The glandular part is subdivided into three zones, according to the types of glands which it contains,

but no distinct lines of division exist. The narrow, yellowish-gray zone next to the non-glandular portion contains the short, tubular *cardiac glands.* Next to this lies a large mottled, reddish-brown area containing the *fundus glands.* The rest of the mucous membrane is reddish-gray in color and contains the *pyloric glands.* The muscular layer is composed of involuntary fibers arranged in longitudinal, circular, and oblique fashion. The serous layer is a

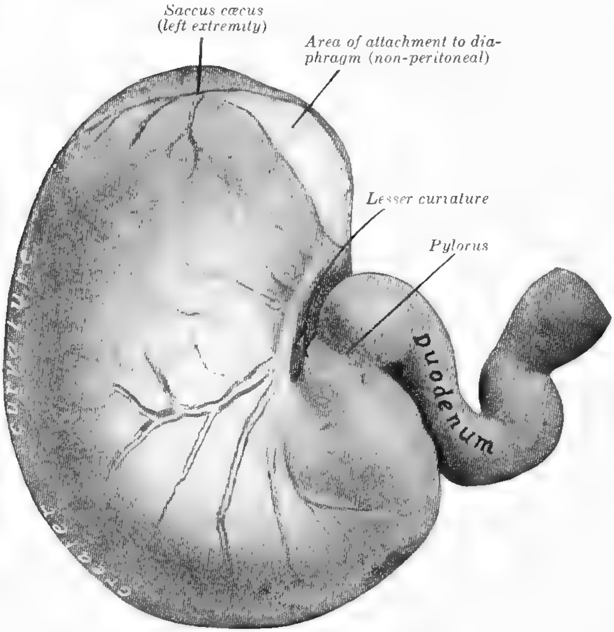

Fig. 17.—Visceral surface of stomach, with first part of duodenum. Fixed *in situ* when full, but not distended. (Sisson, Anatomy of Domestic Animals.)

reflexion of the peritoneum and is continuous with the great omentum.

The **small intestine** is a tube averaging about $1\frac{1}{2}$ inches in diameter and 75 feet long, originating at the stomach and ending at the cecum. It is arbitrarily divided into the *duodenum*, *jejunum*, and *ileum.* The first part is fixed, while the others are floating. It is held in position by the great mesentery. The bulk of the small

intestine lies in the upper part of the left flank, but is changeable in situation, depending on the degree of fulness. About 6 inches from the stomach the common opening of the bile and pancreatic ducts pierces the intestine at the diverticulum duodeni (Fig. 18). From the free surface of the mucous lining numerous small projections, termed *villi*, can be seen when a piece of the membrane

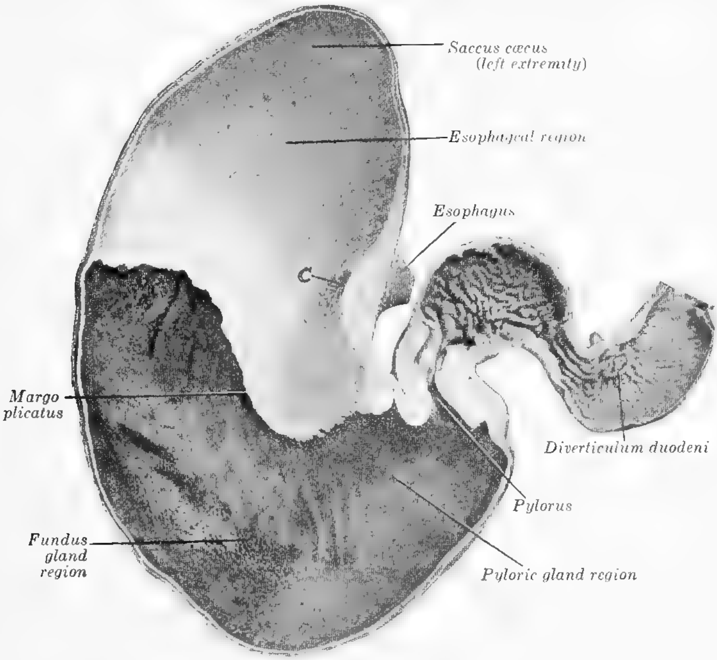

Fig. 18.—Frontal section of stomach and first part of duodenum. The marked difference in the mucous lining of the various gland regions is clearly shown. (Sisson, Anatomy of Domestic Animals.)

is placed in water (Fig. 19). Each villus contains a central lymph-vessel or *lacteal*, by which certain food nutrients are absorbed from the intestine (Fig. 20).

The **large intestine** is divided into the cecum, large colon, small colon, and rectum. It is about 25 feet long and nearly twice the diameter of the small intestine. For the most part it is sacculated.

The **cecum** has a capacity of 7 gallons and is about 3 feet long.

It has two blind ends, and resembles in form an inverted comma. The larger end is attached under the right kidney, while the free end lies on the abdominal floor, giving the organ a downward and forward direction. The two openings of the cecum are placed close together in its crook. The opening for the exit of food material being higher up than the inlet, insures a thorough mixing. The

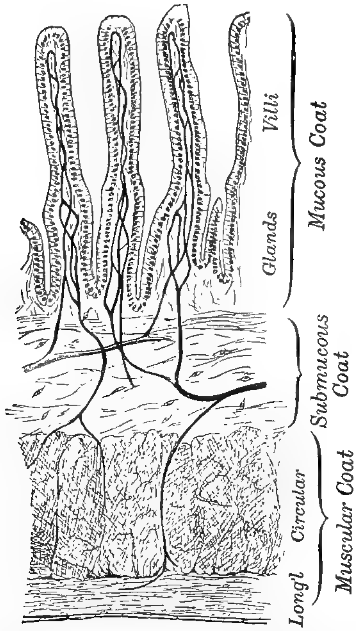

Fig. 19.—Longitudinal section of the small intestine. The submucous coat consists of connective tissue and contains the larger blood-vessels, from which the mucous and muscular coats are supplied with blood. (From Hough and Sedgwick's The Human Mechanism, by permission of Ginn and Company, Publishers.)

latter opening has a valvular arrangement to prevent regurgitation of the ingesta.

The **large colon** is a massive viscus, from 10 to 12 feet long, with an average diameter of nearly 10 inches. It commences at the crook of the cecum and runs downward and forward, along the right costal arch to the sternum, where it curves to the left, and is continued backward on the left part of the abdominal floor to the

entrance of the pelvic cavity. From here it doubles back on itself to the place of commencement.

The **small colon** is the sacculated tube which succeeds the large colon and ends at the rectum. It is 10 to 12 feet long and 3 to 4 inches in diameter. It lies coiled in the left flank with the small intestine. The feces are here converted into the characteristic balls by the contractions of the strong muscular bands of the walls.

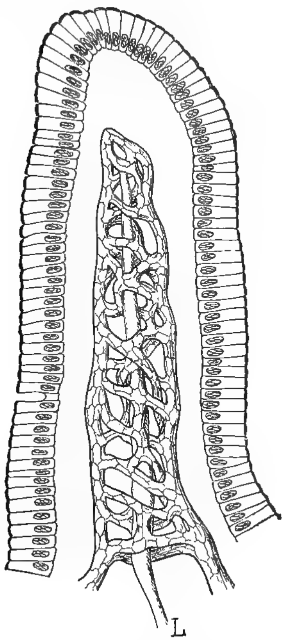

Fig. 20.—Diagrammatic longitudinal section of a villus to show essentials in the structure of a villus. The columnar cells lining the intestine are shown in section. *L*, Lacteal or lymphatic surrounded by a network of capillaries. The connective tissue, which actually exists inside the villus, has been ignored for the sake of simplicity. (Stiles, Nutritional Physiology.)

The **rectum** extends from the entrance of the pelvis to the *anus*, the posterior opening of the digestive canal. It is 10 to 12 inches long and is dilated to form a pouch.

The **liver** is the largest gland in the body (Fig. 21). It is situated in the abdominal cavity, just posterior to the diaphragm.

It is a dark red-brown color, and weighs about 11 pounds in the average-sized horse. The circumference is marked by two fissures which divide the gland into three lobes. Pressure from the soft

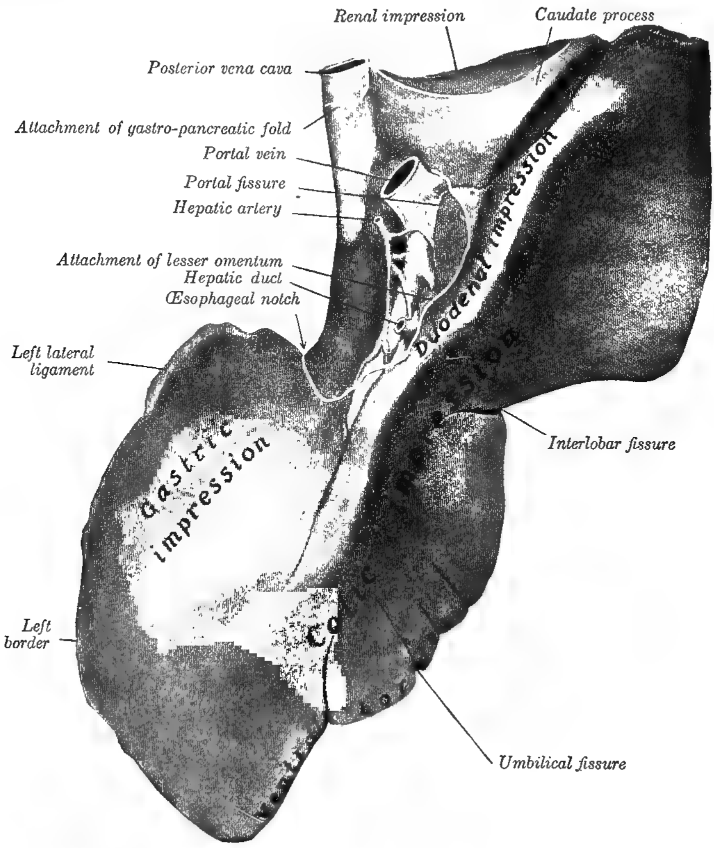

Fig. 21.—Visceral surface of liver. Specimen from a middle-aged horse, hardened *in situ*. The fissures divide the gland into lobes. (Sisson, Anatomy of Domestic Animals.)

organs and special ligaments hold the liver in position. Young horses have relatively larger livers than old horses. The bile-duct connects the liver with the small intestine, which it enters about 6

inches from the pylorus, along with the principal pancreatic duct. In most animals a special reservoir for bile is present in the form of the gall-bladder. The horse has no gall-bladder. Besides having the function of manufacturing bile, the liver acts as a storehouse for glycogen until it is required to nourish the body. The liver is also concerned with the production of a large number of enzymes, which dissolve, transform, precipitate, or completely destroy toxic materials in the blood, especially those brought to the liver from the intestines. Wastes are removed from the blood by the liver. The dual functions have compelled us to look upon this gland as both an excretory and secretory organ.

The **pancreas** so closely resembles a salivary gland in its structure and physical properties that it is commonly referred to as the *abdominal salivary gland.* It is situated behind the stomach and largely below the right kidney. There are two ducts: the larger is the pancreatic duct proper, which has a common opening into the small intestine with the bile-duct; the smaller enters on the opposite side by a special opening. The function of the pancreas is to secrete pancreatic juice.

The **intestinal glands** are of two kinds: the glands of Lieberkühn are very small, tubular structures, and are distributed throughout the entire intestinal tract; Brunner's glands are found in the first 20 feet of the bowel. Unless a close examination is made these glands are not readily seen, as they are embedded in the intestinal walls. The uses of their secretions will be mentioned when digestion is studied.

SECRETION, DIGESTION, AND ABSORPTION

Before food is available for use in the body it must be acted upon by various juices. These are supplied by special secretory glands situated along the course of the digestive canal. Three processes are involved in the preparation of food—secretion, digestion, and absorption. *Secretion* is the process of elaborating the juices of the digestive glands (Fig. 22). *Digestion* is the process of separating the available from the unavailable materials of the food, and consists in dissolving, breaking down, and chemically changing the food so that it can be absorbed by the blood and utilized by the body. *Absorption* is the process whereby digested food nutrients are taken up by the venous and lymphatic systems and passed into the general circulation.

(A) **Digestion in the Mouth.**—The first secretion with which the food comes in contact is **saliva.** This is a fluid of alkaline or neutral reaction and turbid and slimy appearance, which deposits a white precipitate on standing. Besides the 99 per cent. of water which it contains, there are present leukocytes, epithelial cells, a large number of bacteria, and phosphates, chlorids, and sulphates of sodium, potassium, calcium, and magnesium. The composition

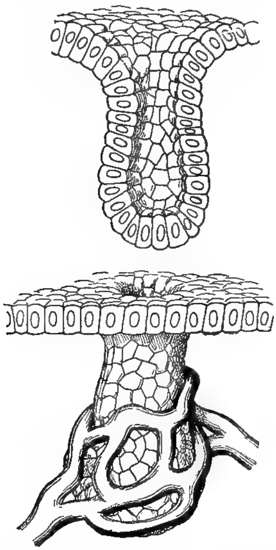

Fig. 22.—The principle of glandular structure. In the upper figure a simple microscopic gland has been laid open by cutting through its vertical axis. The cells are seen to surround a recess, or alveolus, into which they discharge their secretion. Below, the same structure is shown in its entirety, and, in addition, the encircling blood-vessels, which contribute to make good the loss due to the activity of the secreting cells. (Stiles, Nutritional Physiology.)

of saliva varies with the character of the substance in the mouth which has excited it to flow. Coarse sand or irritating chemicals cause a flow of very watery saliva to wash the irritant away; water excites the flow of a very viscid saliva rich in mucin.

The main uses of saliva are to lubricate the food for mastication and swallowing and to aid in digestion. *Ptyalin*, the salivary enzyme, is the principal constituent of saliva from the standpoint

of digestion. It acts on starch, dextrin, and other carbohydrates, converting them into simpler bodies. The first change is a conversion of the huge starch molecule into dextrin and then into malt sugar. Like other enzymes, ptyalin[1] is not destroyed or used up in producing its reaction, but if heated to 60° C. it loses its virtue. It is most active in a neutral medium at the body temperature. In the presence of the free hydrochloric acid of the stomach ptyalin is rapidly rendered inert. The chief part of the salivary digestion actually occurs in the stomach in spite of the hydrochloric acid of the gastric juice, which requires some time to penetrate the food. This is due to the low motility of the cardiac portion of the stomach, the food does not mix with the hydrochloric acid very promptly, and to the fact that this secretion is confined to the fundus and pyloric regions.

(B) **Digestion in the Stomach.**—The stomach is popularly supposed to be the chief organ of digestion; as a matter of fact, in the horse it acts principally as a temporary storehouse for food which is undergoing preparation for the more complex digestive changes designed to take place in the intestines.

Gastric juice is the secretion of the glands of the stomach. The difficulty of obtaining a pure sample from the horse has prevented detailed study. However, the chief constituents are known to be hydrochloric acid and the enzymes, pepsin and rennin. Fresh gastric juice also contains much mucin, but this plays only a passive part in digestion.

Hydrochloric acid is found free in the gastric juice and gives the secretion an acid reaction. It acts as an antiseptic by preventing excessive fermentation and putrefaction through destroying all kinds of bacteria. The percentage is considerably lower in the horse than in carnivora, so micro-organisms are not so readily destroyed, and have a longer opportunity to act on the sugars derived from salivary digestion of the carbohydrates, splitting them into lactic acid. On a diet of starchy food the lactic acid may exceed the hydrochloric acid. The rate of emptying the stomach is controlled in a measure by the hydrochloric acid, but not to such an extent as in the dog, for the pylorus is not usually closed in the

[1] To show the presence and action of ptyalin some starch paste should be prepared. Five c.c. of the paste may be placed in each of as many test-tubes and filtered saliva added in different quantities. By keeping them at various temperatures and testing from time to time with iodin and Fehling's solutions the progress of digestion in the mouth may be nicely demonstrated.

horse. Schattke found an acid reaction in all parts of the horse's stomach ninety minutes after feeding; previous to that time the esophageal portion gave an alkaline or neutral reaction.

Pepsin acts principally on the highly organized protein molecules, converting them into peptones. This conversion is a very complex process and is accompanied with hydration. Pepsin is active only on acidified protein. The presence of the latter stimulates the glands of the stomach to activity.

Rennin has the power to curdle milk. It acts upon the caseinogen of milk and splits it into a proteose-like body and soluble casein. The latter combines with calcium to form insoluble casein. Hammarsten says that some rennin is found in the adult horse's stomach. Probably the foal's stomach secretes much larger quantities.

All experiments recorded in the literature show that when the stomach ingesta are ready to be passed into the intestine they contain a surprisingly constant amount of water. If dry food is eaten, the stomach secretes water to make up the deficiency. On the other hand, if too much water is present, it is passed on to the intestines before gastric digestion is completed. This goes to show that the secretions of hydrochloric acid, pepsin, and water by the gastric glands are independent of each other.

The epoch-making results obtained by Pawlow on dogs, as a result of establishing a gastric fistula for obtaining gastic juice and observing its secretion, have led to an understanding of many obscure phases of digestion, and have provided a basis on which physiologists have been enabled greatly to strengthen our knowledge of dietetics. He demonstrated that the mere sight or smell of food not only causes "the mouth to water," but also stimulates the glands in the walls of the stomach to start secreting gastric juice. When the food enters the mouth both secretions become more active. The gastric secretion keeps up until the entire mass of food in the stomach has undergone gastric digestion.

The Mechanical Action of the Stomach.—The old idea of a churning action in the stomach has given way before recent observations to better founded knowledge. The stomach of the horse is never empty, so gastric digestion is a continuous process in this animal. Sisson has observed that the pylorus is usually open in subjects killed for dissection, and that part of an ordinary feed of hay and oats passes directly into the intestine during ingestion.

When a considerable amount of water is drunk most of it passes at once into the small intestine.

When horses are fed different kinds of foods in succession, it has been found, by killing them at varying intervals after feeding, that the first food taken passes into the most ventral part of the stomach. Subsequently, ingested food is arranged in layers, provided its consistency is sufficient to hold it from forming a mechanical mixture with previously ingested materials (Fig. 23).

There is some difference of opinion in regard to the effect of watering a horse after feeding. It is evident that when a horse which has eaten an ordinary feed drinks any great quantity of

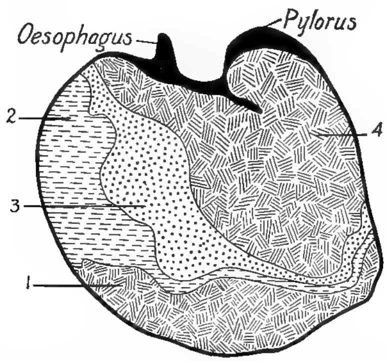

Fig. 23.—Longitudinal section of stomach and contents to show how food is distributed in the stomach. The horse was fed, in turn, (1) 500 grams hay; (2) 750 grams uncolored oats; (3) 750 grams colored oats; (4) 500 grams hay.

water, both cannot be accommodated in the stomach. Scheunert and Schattke[1] conclude, from a series of experiments which they carried out: (1) That the drinking of water in any amount desired by the animal exerted no deleterious effect on digestion. (2) That the increase in the water content of the ingesta was inconsiderable, reaching at most 10 per cent. above the normal average; a similar increase can be produced by the large amount of saliva secreted during mastication of hay or by exercise. The interval before return to the usual lower water content varies individually; in one case it was only ten minutes in duration, but in general appears to be one or two hours. (3) The bulk of the water leaves

[1] Cited by Sisson.

the stomach quickly. When the stomach is well filled the contents are only penetrated very superficially by the water.

(C) **Digestion in the Small Intestine.**—During the process of stomach digestion that portion of the ingesta which has been acted upon by the gastric juice is gradually passed on as chyme into the small intestine.

Chyme is a watery solution of the products of gastric digestion with a large quantity of undissolved matter in suspension. It is soup-like in consistency, and contains most of the fibrous parts of the diet, particularly cellulose. Shortly after reaching the small intestine the chyme becomes neutralized, and then assumes an alkaline reaction from having been mixed with the biliary, pancreatic, and intestinal secretions. These alkaline digestive juices cause the acid albumin to precipitate, which changes the appearance of the chyme to a yellowish, frothy fluid, with clot-like particles held in suspension.

Bile is secreted by the liver, from which it is conveyed to the small intestine by the bile-duct. As the horse has no gall-bladder, the flow of bile is continuous, but is much freer when intestinal digestion is going on than in a fasting animal.

A physical examination of bile shows that it is a watery fluid, alkaline in reaction, and very bitter to the taste. It is yellowish-green in color when fresh, and has an average specific gravity of 1005. According to Colin, from 250 to 310 c.c. of bile are secreted per hour. The principal constituents of the bile are water (about 92 per cent.) the salts of the bile acids, biliary pigments, fats, soaps, sometimes a little protein and inorganic salts, and certain waste products like lecithin and cholesterol.

The salts of the bile acids are present as sodium glycocholate and taurocholate. The former is found in larger quantities in herbivora. The bile-pigments are bilirubin and biliverdin. The first is apparently derived from the blood-pigment. Biliverdin is produced from bilirubin by oxidation, and gives the bile its characteristic color.

Bile acts chiefly as a solvent and emulsifier of fats. It is most active in the presence of pancreatic juice. It does not act on proteins or carbohydrates; in fact, intestinal digestion can proceed without the presence of bile.

Pancreatic juice reaches the intestine by two separate and distinct ducts, as already described. The secretion is indirectly stimu-

lated to production by the presence of the acid chyme from the stomach, which acts on a product of the epithelial cells of the duodenum known as *prosecretin*, changing it into *secretin*. When secretin is absorbed by the blood and reaches the pancreas it stimulates the gland to secrete the pancreatic juice. It also acts on the liver, causing that gland to secrete bile. Secretin is not an enzyme, for it is not destroyed by heat. It cannot be synthetized; in fact, little is known about its properties. To date nothing has been found that can be substituted for it. The average daily secretion of pancreatic juice has not been determined in the horse, but it must be considerable. It has a specific gravity of 1010. Normally, the secretion contains three enzymes—trypsin, amylopsin, and steapsin.

Trypsin is the most important pancreatic enzyme. It is secreted in pro-enzymic form as *trypsinogen*, but is at once activated by the enterokinase of the intestinal juice. It has the power to change proteins into proteoses, peptones, and many other comparatively simple products of protein digestion. *Amylopsin*, or *diastase*, acts on the starchy constituents of the food in much the same way as does the ptyalin of the saliva, converting them into dextrins and sugars. *Steapsin* derives its name from the fact that it splits the fats by hydrolysis into glycerin and their fatty acids. These fatty acids combine with the alkaline salts to form a soapy emulsion.

Intestinal juice is secreted by the glands in the intestinal walls, so has been termed *succus entericus*. It contains several enzymes of much importance to the welfare of the animal. These enzymes include *erepsin*, which is the last agent to act on the products of protein digestion and prepare them for absorption; *invertase*, which has the power to invert dextrose, maltose, and lactose; *enterokinase*, which converts trypsinogen into trypsin. Colin has shown that the intestinal juice of the horse has a distinct action on starch. Furthermore, through the carbonate of soda that is found in it the acid chyme is partially neutralized and made ready for absorption.

Ingesta pass very rapidly through the small intestine. This is evident when a postmortem examination is held. Only a very little content is found, and it is fluid in consistency. The movement of materials from one part of the intestine to another is due, in large measure, to the contraction of the involuntary muscles of the

walls. It occurs as a wave which progresses from the anterior to the posterior part of the bowel. The action is called *peristalsis*, and results in a thorough mixing of the chyme with the secretions from the liver, pancreas, and intestines. When the ear is placed over the flank the peristaltic rumble may be distinctly heard. When the horse stands quietly the noise caused by the moving fluids can be heard at a distance of several feet. Most physiologists believe that the efficiency of intestinal digestion depends as much upon peristalsis as upon the chemical processes produced by the digestive enzymes.

(D) **Digestion in the Large Intestine.**—From the small intestine the ingesta pass into the cecum, where they may remain from twenty-four to thirty-six hours. The cecum is undoubtedly a most important digestive organ in the horse because of its large size and the length of time food remains in it. It always contains considerable ingesta mixed with much water. Ellenberger has called the cecum the second stomach, in which maceration, fermentation, and decomposition changes occur in the food to fit it for absorption. The inlet and outlet are close together, the former being placed below the latter, so the contents must thoroughly mix before passing out. There is no good reason to suppose that material can pass from the small intestine directly into the small colon.

Cellulose is the chief constituent of the roughage in horse feed. It forms the skeleton of plants, and may be seen as undissolved particles in the contents of the cecum and colon. On account of its resistant character, cellulose escapes digestion both in the stomach and small intestine. In the large intestine, however, its destruction is brought about by the swarms of bacteria which thrive in the warm, moist, anaërobic conditions that there prevail.[1]

[1] Cellulose destruction by bacteria can be nicely demonstrated by placing strips of filter-paper in a solution composed of—

Dibasic potassium phosphate	1.0 gram.
Magnesium sulphate	0.5 gram.
Ammonium sulphate	1.0 gram.
Calcium carbonate	5.0 grams.
Water	1000.0 grams.

A large test-tube should be filled two-thirds full of this solution, and 2 grams of horse feces together with two strips of filter-paper added. To exclude air and closely approximate conditions as found in the intestines a layer of paraffin oil ½ inch deep must be poured over the surface of the mixture. Then incubate the tube at 37° C. until signs of decomposition are evident and test for starch and sugar.

These micro-organisms break down the resistant vegetable cells and the cellulose disappears. Just what, if any, part is played by the digestive enzymes in cellulose digestion is a mooted question. It seems doubtful whether they exert any action, for when cellulose is broken down not the slightest trace of sugar can be found, but large amounts of carbon are liberated. It is thought that the carbon combines with hydrogen to form methane, and with oxygen to form carbon dioxid. The expired air contains these gases in relatively large quantities, which has led physiologists to think that, in the horse at least, we can account for their presence in large measure by cellulose destruction. There is reason to believe that the more resistant cellulose-containing portions of the food are not transformed until they have been acted upon by the various agents noted above and reach the last portion of the large colon. On the strength of these facts, it seems unreasonable to attribute much heat value to cellulose destruction. The process may be considered simply an accident in the course of digestion.

Immediately after passing into the small colon a very marked change occurs in the character of the contents; from a greenish-brown pea-soup-like mass it becomes firmer and resembles quite closely fresh feces. As the material is moved on toward the rectum it gets drier and is molded into characteristic balls through the action of the muscular bands in the walls of the small colon. Smith states that the reaction is still alkaline or neutral at this point, but after reaching the rectum a distinctly acid reaction is obtained on the surface of the fecal balls.

Feces represent the residue of digestion. They have a disagreeable, but not exactly a repulsive, odor even in health, due to indol and skatol. When digestive disturbances are present they become extremely offensive. They are collected in the pouch-like dilatation of the rectum. When the rectum is sufficiently full to cause a reaction in its walls from pressure it is voluntarily emptied. The act is termed *defecation*. Voluntary defecation becomes impossible when paralysis of the rectum exists. The feces contain approximately 76 per cent. water, 21 per cent. organic matter, and 3 per cent. mineral matter. Grass and other succulent foods result in soft excreta, while dry foods, especially concentrates, have a constipating effect. The color varies with the character of the food. A thin coating of mucus covers the feces and gives them a shiny appearance. Smith observed that horses on a diet consisting

of 12 pounds of hay, 6 pounds of oats, and 3 pounds of bran passed 29 pounds 13 ounces of feces in twenty-four hours. It takes about four days for food to pass through the alimentary tract of the horse, but solid bodies have been found in the feces after twenty-four hours.

Meconium is the fecal material found in the intestines of the fetus. It consists largely of waste products from the liver. The first milk (colostrum) contains substances which hasten bowel action and cause the meconium to be expelled soon after birth.

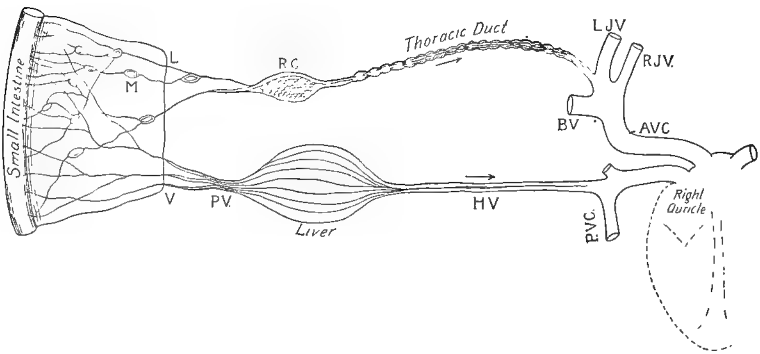

Fig. 24.—Diagrammatic representation of the two paths of absorption: V, Veins of the mesentery which unite to form the portal vein, P.V.; H.V., hepatic vein; P.V.C., posterior vena cava; L, lacteals which convey through mesenteric lymph-glands, M, to the receptaculum chyli, R.C.; L.J.V., left jugular vein; R.J.V., right jugular vein; B.V., brachial vein; A.V.C., anterior vena cava.

The essential points mentioned in connection with digestion may be summarized as follows: Digestion involves a reduction of foods to their simplest forms, and in most cases they are probably made water-soluble. The carbohydrates are changed to sugars, the fats to fatty acids and glycerin, the proteins to amino-acids, and the cellulose to decomposition products. With the possible exception of the latter, all afford available heat for the body when undergoing their respective modifications.

(E) **Absorption from the Digestive Canal.**—The process of absorption is complicated from the fact that there are two paths by which the products of digestion may enter the general circula-

tion; these are: (1) the small veins that run together to form the portal vein of the liver; (2) the lacteals, which convey by way of the mesenteries through groups of lymphatic glands to the receptaculum chyli and then into the thoracic duct (Fig. 24).

The portal vein carries all the blood from the stomach, spleen, and intestines to the liver, which is placed between the digestive and circulatory systems. Through it must pass all the products of protein and carbohydrate digestion. These include amino-acids, carbohydrates, ammonia, and toxic materials.

Amino-acids comprise a number of organic substances, among which are aspartic acid, arginin, cystin, histidin, leucin, lysin, phenylamin, prolin, tryptophan, and tyrosin. When any one of these is lacking in the ration, starvation will ensue. They represent the last stage in protein digestion; further cleavage would probably render the nutrients unsuitable for use by the body. The amino-acids pass through the liver unchanged and go to the muscles and other tissues of the body, where they appear to be synthetized into such body-proteins as muscle and ligamentous tissue, or otherwise made available as a source of energy and heat. At one time it was believed that the proteins were broken down only so far as proteoses and peptones, in which forms they were absorbed. Now we know that there is a further cleavage, for not only is it impossible to find even traces of these substances in the blood of animals fed on a very high protein diet, but by injecting purified proteose and peptone into the blood-stream of experimental animals death ensues at once, due to their toxicity. The theory at present most generally accepted is that protein substances are absorbed as amino-acids, the final conversion being the result of the action of the enzyme erepsin.

Carbohydrates are found in the circulating blood, liver, and muscles. They are absorbed as glucose. The animal can subsist if no carbohydrates are in the food.

Ammonia originates, according to Folin, almost entirely in the large intestine as a result of putrefaction of the residue of digestion. It is largely disposed of in the liver by combining to form urea, the chief waste substance excreted in the urine.

Toxic materials are absorbed in considerable amounts from the intestines. Upon reaching the liver they are destroyed or rendered harmless. This important function of the liver was demonstrated nicely by Schiff, who injected a dose of nicotin through a

peripheral vein and caused death, while the same dose introduced into the portal vein was without effect.

Fats are absorbed only by the lacteals, but as fatty acids and glycerin rather than true fats. They appear to be again converted into fats by the action of the epithelial cells in the walls of the intestine. Fats, like proteins and carbohydrates, are fuel foods, and are used as a source of body heat and energy. Although they are not carried directly to the liver, as are the proteins and carbohydrates, they frequently are accumulated there until required for use. Most cells and tissues of the body have the power to store fats for future use. This function varies with the character of the tissues.

THE DUCTLESS GLANDS AND THEIR FUNCTIONS

The principal glands without ducts are the spleen, the thyroid, the thymus, the adrenals, and the pituitary and the pineal bodies. Little is known about the functions of these glands. In recent years it has been found that they play important rôles in the elaboration of the so-called *internal secretions*, which pass directly into the veins or lymphatics instead of being conveyed away by ducts.

The **spleen** is a large vascular organ situated in the left portion of the abdominal cavity. It is sickle shaped, weighs a little more than 2 pounds, and averages 20 inches in length (Fig. 25). It is bluish-red in color, and is soft but not friable in the natural state. The function of the spleen is not positively known, but it is supposed to have something to do with the formation and destruction of the red blood-corpuscles which are found in the organ in great numbers. Animals live with little inconvenience when it is removed.

The **thyroid gland** is situated in the neck below the anterior part of the trachea. It may be easily felt in the living horse. It is very vascular, firm in texture, and dark red-brown in color. Enlargement of the gland results in the disease termed "goiter." An important internal secretion is produced by the thyroid, which has to do with the process of nutrition. Animals live but a short time after the gland has been removed. If they are fed on fresh thyroid gland from another animal they seem to suffer no inconvenience.

The **thymus gland** is found between the heart and the larynx. In late fetal life and the very young animal it is seen as a long chain

of gland-like tissue extending the entire length of the trachea. It atrophies rapidly after birth, and appears to play a function only during the development of the fetus. As a food it is considered by many a delicacy, and is known as the "sweetbread." In animals castrated early it atrophies much slower than in stallions.

Fig. 25.—External surface of spleen: *a*, Dorsal extremity or base; *b*, *c*, anterior and posterior basal angles; *d*, anterior border; *e*, apex; 1, 2, 3, impressions of last three ribs. (Sisson, Anatomy of Domestic Animals.)

The **adrenals** are paired ductless glands situated in contact with each kidney (see Fig. 29). They are about 3 inches long and $1\frac{1}{2}$ inches wide. Rapid death follows their removal, due to inter-

ference with the circulation. A substance known as adrenalin has been extracted from the glands. It exerts a powerful action on the small blood-vessels, contracting them to a marked degree and causing an enormous rise in the blood-pressure.

The **pituitary** and **pineal bodies** lie at the base of the brain. The administration of pituitary extract to lactating animals greatly increases the quantity of milk secreted and also its fat content. The increase is temporary, as the extract becomes less and less effective as time goes on. Injections of pituitary extract are said to correct uterine inertia at parturition, to shorten the period of labor, and to prevent collapse by stimulating the heart.

CHAPTER V

THE RESPIRATORY SYSTEM

THE ORGANS OF RESPIRATION

THE *respiratory apparatus* comprises the nasal cavity, the pharynx, the larynx, the trachea, the bronchi, and the lungs. The lungs are the essential organs of respiration; all the other parts simply act as passages for air to and from them. Two accessory structures, the pleura and diaphragm, will also be briefly described in this chapter.

The **nasal cavity** is a cylindric passage divided by the cartilaginous nasal septum into symmetric halves. Its walls are made up of portions of all the facial bones except the mandible and hyoid. In the living animal it is lined by mucous membrane, which is continuous at the nostrils with the skin and posteriorly with the lining of the pharynx. The *nostrils* are supported and kept dilated by two comma-shaped alar cartilages attached to the nasal septum. A blind, pouch-like diverticulum of the skin, called the *false nostril*, lies above each nostril. The external opening of the nasolacrimal duct may be seen on the floor of the nasal cavity about 2 inches from the nostril when the latter is dilated. The two turbinated bones divide each half of the nasal cavity into three passages or meatuses—the superior, middle, and inferior. Of these, the inferior meatus is the largest, and is the direct communication between the nostrils and the pharynx. It runs along the upper surface of the palatine process of the maxilla.

The **pharynx** has been described with the organs of the digestive system, as it is common to both the digestive and the respiratory tracts.

The **larynx** is a short, tube-like apparatus placed between the pharynx and the anterior end of the trachea. It regulates the amount of air passing to and from the lungs and prevents the aspiration of foreign bodies. It is made up of five pieces of cartilage—the cricoid, the thyroid, and the epiglottis, which are

single, and the arytenoids, which are paired. These cartilages articulate by true joints, and are moved by means of two systems of muscles—(1) the extrinsic group, which find one attachment to the larynx and the other to some point outside the organ; (2) the intrinsic group, which pass between the different cartilages. The interior of the larynx shows two vocal cords stretched from the lateral walls; the opening between these cords is called the glottis. When the vocal cords vibrate, sounds are produced. On each side of the larynx is a pocket-like depression of mucous membrane, known as the ventricle.

The **trachea** connects the larynx with the lungs. It is formed of fifty to fifty-five rings of cartilage, attached to each other by a fibro-elastic membrane. The rings are not complete circles, for their two ends overlap superiorly. Through these rings the organ is kept permanently open and is made flexible. The average caliber is about $2\frac{1}{2}$ inches. At the entrance to the lungs the trachea divides to form the bronchi.

The **bronchi** are two in number, the right being the larger. Together with the pulmonary vessels they form the "root of the lung." They are continued posteriorly by the smaller bronchial tubes, which ramify throughout the lungs.

The **lungs** are designated right and left. They practically fill the *thoracic cavity*. Three systems of tubes embedded in connective tissue are found in the lungs: (1) the ramifications of the bronchi; (2) the pulmonary arteries; (3) the pulmonary veins. For description, each lung may be considered as having a base, an apex, and two surfaces. The base is situated against the diaphragm, which conforms to its shape. The apex lies opposite the first and second ribs. The external surface is convex and adapted to the ribs and the intercostal muscles. The internal surface is irregular and less extensive. In the living animal the lung is of a pinkish color, due to the blood in its tissues. It becomes pale gray in the bled subject, while the unbled lung is dark red. The lung is soft, spongy, and very elastic. It floats in water.

Minute Structure of Trachea, Bronchi, and Lungs.—A histologic examination of the trachea shows it to be lined with a mucous membrane composed of ciliated epithelium, interspersed with mucous cells. The former actively wave backward and forward during life and work the dust-ladened mucus toward the mouth. The bronchi and bronchial tubes have flakes of cartilage rather

than rings of this tissue in their walls. This gives them a flexibility, and yet sufficient rigidity, so that they are extremely efficient as tubes for conducting the air. Each bronchial tube divides and subdivides until the extremely small tubes termed bronchioles are formed. *Bronchioles* end in minute compartments, about $\frac{1}{25}$ inch in diameter, known as alveoli. Each *air alveolus* has several air cells, as shown in Fig. 26. The *air cells* average only $\frac{1}{100}$ inch in diameter. Their walls are composed of a single layer of

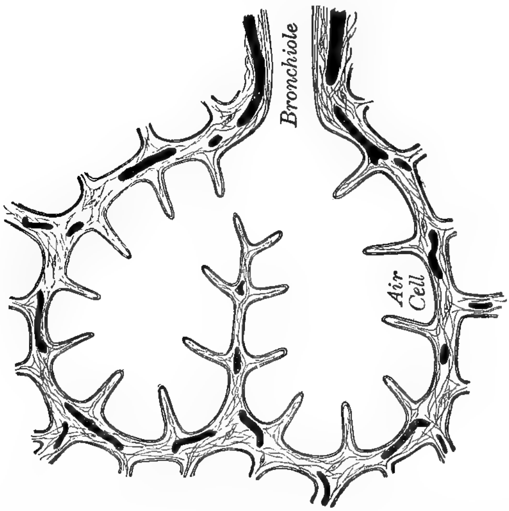

Fig. 26.—Diagram of a longitudinal section of two alveoli with their common bronchiole, and showng in black the larger blood-vessels in the connective tissue. (From Hough and Sedgwick's The Human Mechanism, by permission of Ginn and Company, Publishers.)

epithelial cells, supported and given elasticity by fibers of yellow elastic tissue. The interchange of gases between the external air and the blood takes place through these cells. The alveoli are bound together in groups by connective tissue to form larger masses, termed *lobules*. These lobules, in turn, are joined to form the different *lobes* of the lung.

The **pleura** is the serous membrane which lines the *thoracic cavity*. It is arranged to form two sacs, and is reflected at the roots of the lungs to invest these and other organs in the cavity. Its

disposition is similar to that of the peritoneum. The pleura is kept moist by a serous fluid, the liquor pleuræ; in health there is only enough to permit the lungs to glide on the walls of the cavity with the minimum amount of friction, but it accumulates rapidly in some forms of pleurisy.

The **diaphragm** forms the partition between the thoracic and abdominal cavities (see Fig. 28). It is a large muscle with a peripheral fleshy portion, two muscular pillars, and a tendinous center. The anterior surface is convex, covered by the pleura, and related to the bases of the lungs and pericardium. The posterior surface is concave, covered for the most part by the peritoneum, and in contact with the liver, stomach, flexures of the colon, and the kidneys. There are three foramina in the diaphragm—the dorsal one is for the passage of the aorta, the left one for the esophagus, while the right foramen gives passage to the posterior vena cava.

THE PHYSIOLOGY OF RESPIRATION

During life the lungs lie in an air-tight enclosure, the *pleural cavity,* in which there is a constant negative pressure. In the average condition of expansion the normal elasticity of the lungs of a man is capable of supporting a column of mercury 30 mm. in height, so they are always tending to collapse. When the atmospheric air, with a pressure of 760 mm. of mercury, is admitted to the lungs at birth it immediately causes these distensible and elastic organs to inflate, because the normal atmospheric pressure is greater, by about 730 mm., than that which tends to collapse them. This explains why the lungs are kept expanded and in contact with the chest wall under natural conditions. If the thoracic wall is perforated and the external air is allowed to rush into the pleural cavity, the lungs immediately collapse, for now, in addition to the contractility force of the lungs, there is added the atmospheric pressure, against which is only the normal pressure from the air in the lungs.

The **mechanism of breathing** may be best understood by studying the movements of lungs recently removed from a living rabbit, dog, or pig, and placed in an apparatus similar to that illustrated in Fig. 27. The glass bell-jar represents the thoracic walls. The jar is closed beneath by a sheet of rubber (*D*), to take the place of the diaphragm. Conditions that closely approximate the normal pleural cavity may be thus obtained. By partially exhausting the

air in the bell-jar through the tube with the pinch-cock attachment a negative pressure may be made. If the sheet of rubber at the bottom of the apparatus is pulled downward, the size of the cavity will be increased and the pressure still further lowered, causing the air to rush in through the trachea and expand the lungs (*L*). When the pull is released, the pleural pressure rises, and the lungs tend to collapse and force the air out. The bell-jar used as a model for our illustration was larger than necessary, and may give a wrong

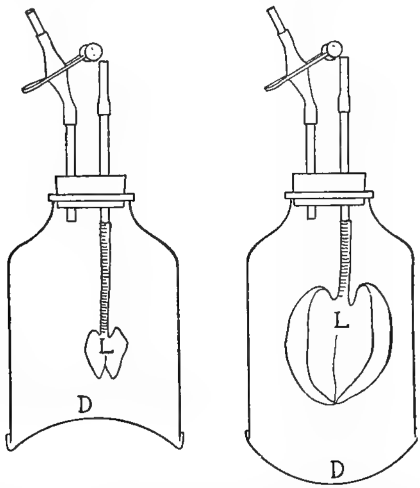

Fig. 27.—Apparatus to illustrate the mechanics of respiration: L, Lungs of experimental animal; D, rubber diaphragm. At the left the lungs are collapsed and the diaphragm relaxed, as occurs after expiration; at the right the diaphragm is contracted, which increases the negative pressure around the lungs and allows the air to rush into and expand them.

impression, unless it is remembered that in life the lungs and other organs completely fill the thoracic cavity, so that no air space exists between them.

Respiration is the act of breathing. Obviously, it is the most vital function of animals. It consists of (*A*) an exchange of the oxygen in the air for the carbon dioxid in the blood, and (*B*) an interchange of these gases between the blood and the body tissues. The first exchange is termed "external respiration"; the second, "internal respiration."

External respiration consists of inspiration, a movement in which the lungs are filled with air, and expiration, by which the inspired air is expelled from the lungs and these organs are ventilated.

Inspiration is brought about by a contraction of the diaphragm, which causes this partition to flatten, particularly at the sides, so that the length of the thorax is increased (Fig. 28). The ribs are

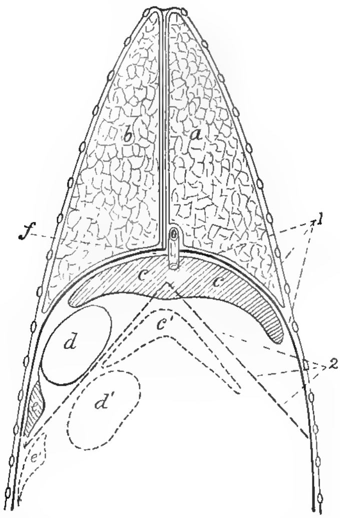

Fig. 28.—Horizontal section of chest to show the movements of diaphragm: *a*, Right lung; *b*, left lung; 1, position of the diaphragm during deep expiration; *c*, liver; *d*, stomach during deep expiration; *e*, spleen during deep expiration; 2, position of the diaphragm during deep inspiration; *c'*, liver; *d'*, stomach; *e'*, spleen; *f*, posterior vena cava as it passes through its foramen in the diaphragm. (Sussdorf.)

rotated outward and forward by the external intercostal muscles attached to them. As a result of these changes both the girth and transverse diameter of the chest is increased, and the thorax is greatly expanded, so as to permit of full inspiration.

Expiration is made possible by the relaxation of the muscles employed in inspiration. Normally it is mainly a passive act. The diaphragm springs forward rapidly, due to pressure from the abdominal viscera. This causes the lungs to be compressed and

forces most of the air out of them. The balance of the air normally exhaled depends for its expulsion on the contraction of the internal intercostal muscles, which help draw the ribs backward and downward. When breathing is forced or labored, these and the abdominal muscles also come into play to aid in reducing the size of the thorax.

The air which is exhaled in normal, quiet respiration is known as tidal air; the supplemental air is that which can be voluntarily breathed out after a quiet expiration; the residual air is that which the animal is unable to force out of the lungs. To show that residual air is present in considerable amount, the lungs of a recently killed animal should be placed in water, in which they will be found to float. Fetal lungs sink in water, for the air-cells have never been filled with air.

Internal respiration consists of the passage of oxygen from the blood to the tissues, and the passage of carbon dioxid and other impurities from the tissues to the blood. Two factors are at work in this interchange—the mechanical diffusion due to the difference in oxygen pressure, and the vital action of the endothelial cells which line the capillaries. The extent of the latter action is not known, but it probably is important. True respiration and oxidation really take place between the body cells and the lymph which bathes them. Lymph contains both oxygen and carbon dioxid; the blood is constantly supplying the first and removing the latter. In other words, breathing is not respiration, in the exact sense of the term, though it is a necessary adjunct to the process.

The **respiratory center** for regulating breathing is a collection of nerve-cells located in the medulla oblongata. Special nerve-fibers run from this center, by way of the vagus nerve trunk, to the lungs and the muscles concerned in respiration. This permits the lungs to be ventilated by reflex action. Among the things which stimulate the respiratory center are carbon dioxid in the blood, the presence of various products of metabolism in the blood, and a low oxygen content of the blood, as occurs in high altitudes. A perfect balance is maintained in health between the amount of carbon dioxid and oxygen in the blood by the action of the respiratory center on the movements of respiration.

THE CHEMISTRY OF RESPIRATION

A clue to the chemical changes that take place in the lungs may be had by comparing the composition of inspired and expired air. From a physiologic standpoint the essential constituents of atmospheric air are oxygen and nitrogen. The accompanying table shows the average per cent. of each:

	O.	CO_2 and CH_4.	N.
Inspired air	21.0	0.0	79
Expired air	16.5	4.5	79
Difference	4.5	4.5	0

It is seen that the respired air loses oxygen and takes on carbon dioxid and methane. The former is largely derived from oxidation of the various organic compounds of the body. The latter comes, in most part, from the destruction of cellulose in the intestines.

The amount of oxygen absorbed and other gases given out varies with the size of the animal and the activity of the tissues of the body. In a state of rest a horse of 1100 pounds weight has been found to absorb 5260 liters of oxygen, and give out 5060 liters of carbon dioxid in twenty-four hours. During exercise these amounts are greatly increased. Exposure to cold causes increased oxidation and a corresponding increase in the respiratory exchange.

The amount of air breathed by a horse, as determined by King, was found to be 142 cubic feet per hour and about 3400 cubic feet per day. When air contains over 3.3 per cent. of air that has been previously breathed it is considered impure or contaminated. To provide a stabled horse with substantially pure air necessitates an hourly supply of 4296 cubic feet, or more than 100,000 cubic feet each twenty-four hours.

A reduction in the amount of oxygen in the respired air in a stable is not the only detrimental influence on the health of the animal. The accumulation in the stable of the waste products of the body is of just as much importance. Excreta liberate free ammonia and other volatile substances in large quantities. Experiments have shown that the oxygen content of the air can be reduced from about 21 per cent. to as low as 5 per cent. without appreciable detrimental effect, provided the feces and urine are

promptly removed. These facts emphasize the great importance of proper stable ventilation and sanitation, and show that pure air is an essential requirement for health.

Oxygen is carried in the blood by the red blood-corpuscles. The hemoglobin of the corpuscles is largely responsible for this power. It has a marked affinity for oxygen, with which it easily combines.

The following table shows the approximate difference between the gas content of human blood before and after it has circulated through the tissues:

	O.	CO_2.	N.
100 c.c. arterial blood	20 c.c.	38 c.c.	1.5 c.c.
100 c.c. venous blood	10 c.c.	48 c.c.	1.5 c.c.
Difference	10 c.c.	10 c.c	0.0 c.c.

These figures also signify that there is always a considerable amount of carbon dioxid in arterial blood, and a corresponding amount of oxygen in venous blood. Furthermore, they show that the tissues do not remove all the oxygen, nor do the lungs remove all the carbon dioxid from the blood circulating through them.

There is some difference of opinion about the exact method of absorption of oxygen by the fluids and cells of the body. For our purposes the well-known chemical law of Dalton in relation to changes in gases may be accepted as the explanation.

CHAPTER VI

THE UROGENITAL SYSTEM

The *organs of urination* and *reproduction* are studied together, because some of them serve both as passages for the urine and the products of the genital organs.

THE ORGANS OF URINATION

These are the kidneys, the ureters, the bladder, and the urethra.

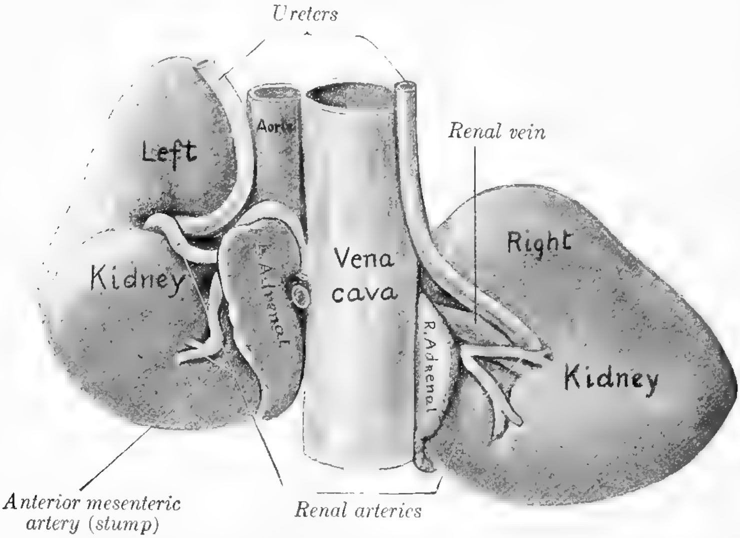

Fig. 29.—Kidneys and adrenal glands, ventral view. Photograph of organs hardened *in situ*. (Sisson, Anatomy of Domestic Animals.)

The **kidneys** are paired excretory glands (Fig. 29). The right kidney is heart shaped, and is placed under the upper ends of the last two ribs and the transverse process of the first lumbar vertebra.

It is in contact with the liver in front and the pancreas below. The left kidney is bean shaped, and lies about 2 inches further back than its fellow. Each kidney has on the inner border a hilus or opening for the renal artery, veins, and nerves. Through this hilus the ureter leaves. The average weight of the right kidney is about 23 ounces; that of the left, about 22 ounces. A tough, fibrous capsule, which can be easily stripped off, covers each kidney. On section, two distinct zones of kidney substance are seen (Fig. 30). The outer or cortical substance is reddish-brown in color, and contains many minute, dark, pin-head points, which are the glomeruli

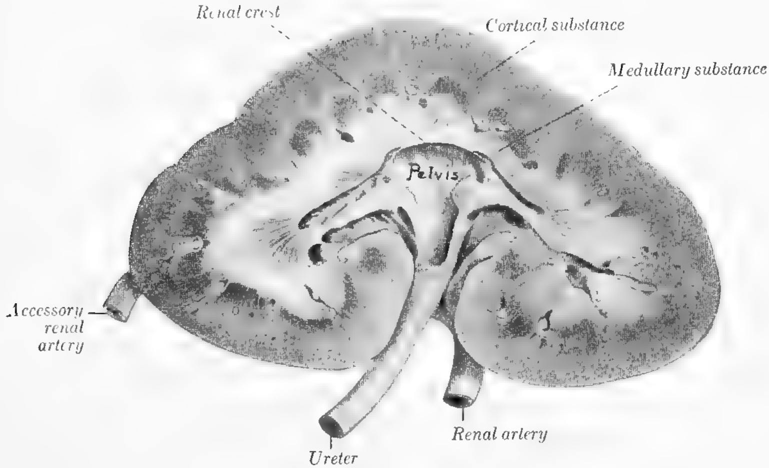

Fig. 30.—Horizontal section of kidney. The white areas are sections of arteries. (Sisson, Anatomy of Domestic Animals.)

or blood-vessel tufts. The inner or medullary substance is lighter in color and appears striated, due to the numberless uriniferous tubules which are found here. The *pelvis* is the central cavity where the urine is received from the collecting tubules. The renal artery is remarkable for its great size. The *minute structure of the kidney* reveals on inspection a compound tubular gland (Fig. 31). Each *uriniferous tubule* commences at a closed expanded end which surrounds the *glomerulus,* or tuft of capillary blood-vessels, the whole mechanism being known as the *malpighian body.* The tubule projects into the medullary substance in a con-

voluted manner, forms two loops, and finally opens into a collecting tubule which conveys the urine to the pelvis of the kidney.

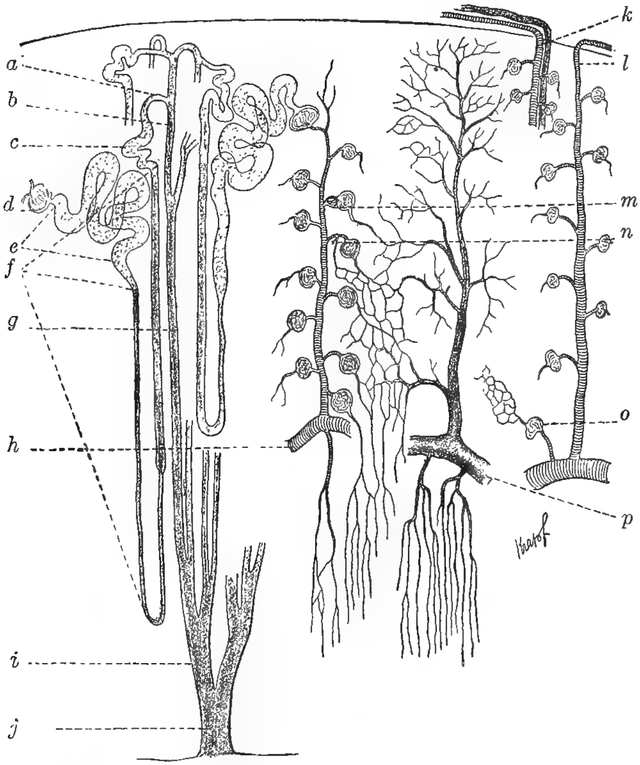

Fig. 31.—Diagrammatic scheme of uriniferous tubules and blood-vessels of kidney: *a*, Arched collecting tubule; *b*, straight collecting tubule; *c*, distal convoluted tubule; *d*, renal (malpighian) corpuscle; *e*, proximal convoluted tubule; *f*, loop of Henle; *g*, collecting tubule; *h*, arteria arciformis; *i*, large collecting tubule; *j*, papillary duct; *k*, artery of capsule; *l*, interlobular artery; *m*, capillary network, vas afferens; *n*, arteriola recta spuria; *o*, glomerulus; *p*, vena arciformis. (Böhm, Davidoff, and Huber.)

The **ureters** are thick-walled ducts about the size of a goose quill, which connect the kidney with the bladder. Their course, of about 26 inches, is along the sublumbar muscles into the pelvic cavity. They have muscle-fibers in their walls which show

a rhythmic, peristaltic contraction that forces the urine along. The backward passage of the urine into the ureters is prevented by the oblique manner in which they pierce the wall of the bladder.

The **urinary bladder** is located on the floor of the pelvis. When full it is egg shaped, and may extend over the brim of the pubis into the abdominal cavity. Near its posterior or constricted part are found the openings of the ureters. The wall is composed of an inner mucous coat, a middle muscular coat of involuntary fibers, and an outer serous covering which does not extend over the entire organ. The bladder functions as a reservoir for the urine. The act of expelling urine from the bladder is termed "micturition."

The **urethra** is a single tube which carries away the urine from the bladder. The orifice into the urethra is guarded by a ring-like muscle which completely closes it when in a state of contraction. In the male it is a common tube to the urinary and genital systems, and will be described with the latter. The *urethra of the mare* is about 2 inches long and connects the bladder with the vulva, into the floor of which it opens by the *meatus urinarius*, about a hand breadth from the external opening of the vulva.

THE PHYSIOLOGY OF URINATION

The blood enters the glomerulus of the malpighian body under pressure, where it meets with opposition to its outflow. Here most of the water and soluble salts found in urine are excreted. The process is not a simple filtration, as was at one time supposed, but involves a selective action of the epithelial cells lining this portion of the uriniferous tubule. After they leave the malpighian bodies the uriniferous tubules are lined with cells capable of extracting from the blood the urinary pigments and solids that were not allowed passage at the expanded end of the tubules. These are flushed out by the fluid from above, and are carried to the pelvis of the kidney by the collecting tubules, as previously described.

It is evident from this brief review of the activities of the kidneys that the flow of urine will be increased (1) by raising the blood-pressure; (2) by increasing the water content of the blood through absorption from the intestines; (3) by retarding the elimination of fluids by other channels of the body, like the digestive and respiratory tracts and the skin. When these conditions are reversed the flow of urine will be reduced.

The **function of the kidneys** is, concisely, to elaborate the urine. Careful study has shown that in doing this they are active in maintaining (1) the concentration of the blood by regulating the salt content; (2) the volume of the blood by regulating the water content; (3) the neutral reaction of the blood by converting sodium acid phosphate to sodium phosphate. Furthermore, when the liver fails to function properly the kidneys compensate by eliminating larger amounts of ammonia and other waste products than they do normally.

Urine is the most important excretion of the body. By it are eliminated the nitrogenous products of metabolism, also the water and soluble mineral substances. The amount and composition varies with the age, the character of the food and drink, and the state of metabolism. The average amount voided in twenty-four hours is about 3000 to 4000 c.c., but may be as much as 9000 c.c. When sweat is profusely excreted the urine is proportionately reduced in amount. It is alkaline in reaction unless the animal is starved. Equine urine has a specific gravity of about 1035, and is turbid from the presence of the carbonates of lime which it contains. The most important organic constituents are: urea, ammonium salts, diureids, creatinin, and carbonic, uric, and hippuric acids. Of these, urea and hippuric acid are found in relatively large quantities. The former comes from the putrefaction of proteins in the intestines, while the latter is formed chiefly from the benzoic acid in the roughage, and is present in larger amounts upon a diet consisting mostly of hay or grass than when concentrates are fed.

THE REPRODUCTIVE ORGANS OF THE STALLION

Starting with the testicles as the central structures of the male genital tract, the following organs are found in succession—the testicles and their covering, the scrotum, the vas deferens, the seminal vesicles, the prostate and Cowper's glands, and the penis (Fig. 32).

The **testicles** are two egg-shaped glands situated in the inguinal region. They are composed of glandular tissue and have a worm-like appendage of seminiferous tubules known as the *epididymis*. They are developed in the sublumbar region, and may descend prior to birth through the *inguinal canal* into the scrotum. In the majority of cases the colt is several weeks old before they can be

felt. When either or both testicles fail to pass into the scrotum the horse is said to be a cryptorchid or ridgling. A serous membrane, the *tunica vaginalis propria,* closely envelops the testicle. It is a

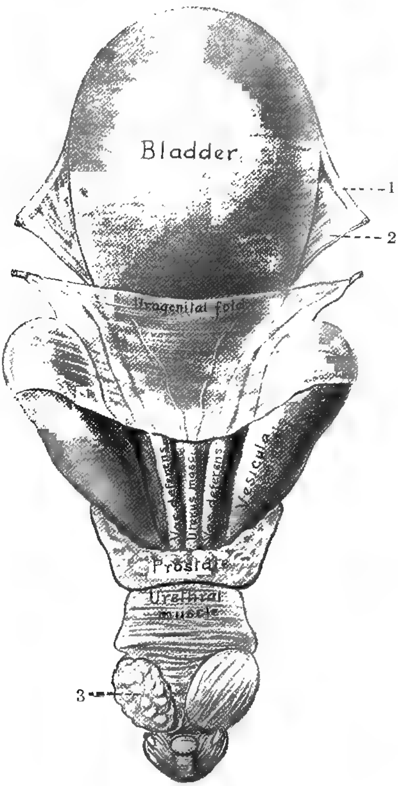

Fig. 32.—Internal genital organs of stallion, dorsal view: 1, Round ligament of bladder; 2, lateral ligament of bladder; 3, Cowper's gland. The branches of the uterus masculinus are indicated in the genital fold. (Sisson, Anatomy of Domestic Animals.)

reflection of the abdominal peritoneum. The testicles secrete the *spermatic fluid* or *semen.*

The **scrotum** is the sac in which the testicles are normally enclosed. It has an outer layer of soft, oily skin, beneath which is a strong fibrous layer. The *tunica vaginalis communis* lines the

scrotum. It is a serous membrane, and directly continues the peritoneum, of which it is a pouch-like diverticulum. Between the two vaginal tunics is normally found a potential cavity containing a serous fluid to prevent friction as the testicle changes position.

The **vas deferens** is a thick-walled duct, about $\frac{1}{8}$ inch in diameter, which carries away the secretion of the testicle. There is one for each of these glands. It passes upward through the inguinal canal to the abdominal and pelvic cavities. It ends by entering the urethra.

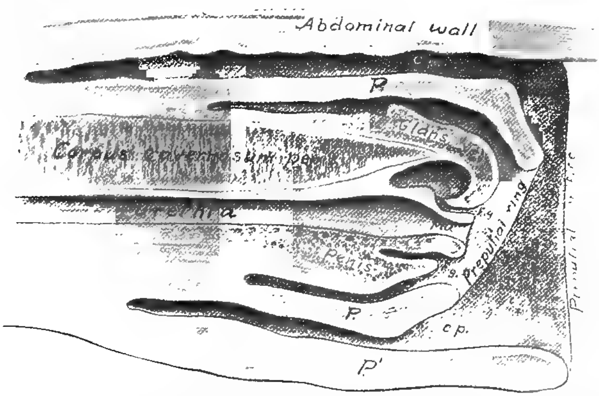

Fig. 33.—Section of prepuce and part of penis: *P*, Internal part of prepuce or prepuce proper; *P′*, external part of prepuce or sheath; *C.p.*, preputial cavity; *F.g.*, fossa of glands; *D*, diverticulum; *P.u.*, end of urethra. (Sisson, Anatomy of Domestic Animals.)

The **spermatic cord** is that mass of tissue which is severed when the stallion is castrated. It is composed of the vas deferens, the blood-vessels, the nerves and the cremaster muscle, and serous coverings of the testicle.

The **seminal vesicles** are two sacs, about 6 inches long, which project forward from the dorsal surface of the posterior part of the bladder. In some animals they serve as reservoirs for the semen, but in the horse do not appear to so function.

The **prostate** and **Cowper's glands** lie at the beginning of the urethra. They secrete fluids which are poured into the latter tube for the purpose of facilitating the passage of semen. They also

dilute the secretion from the testicles, adding volume to it, and thus affording a greater opportunity for it to reach the ovum.

The **penis** is largely composed of erectile tissue—the *corpus cavernosum*. The organ extends from the ischial arch, where it is firmly attached, forward between the thighs. It has at the free end a covering of skin, called the *prepuce* or *sheath* (Fig. 33). The inner layers of the prepuce are supplied with large sebaceous glands, the secretion of which has a tendency to collect here and cause "foul sheath" unless washed out at intervals. When the diverticulum of the fossa of the glans penis becomes filled with smegma it causes the formation of a "bean," which sometimes materially interferes with urination. The penis is the male copulatory organ.

The **urethra of the stallion** is the long mucous tube which extends from the bladder to the lower or anterior end of the penis. It passes backward on the floor of the pelvis, turns around the ischial arch, and then runs forward and downward, embedded in the spongy tissue of the penis. The urethra conveys both the urine and the semen.

THE REPRODUCTIVE ORGANS OF THE MARE[1]

The female genital organs are the two ovaries, the fallopian tubes, the uterus, the vagina, the vulva, and the mammary glands (Fig. 34).

The **ovaries** are two in number, bean shaped, and much smaller than the testicles, with which they are homologous. They are situated about a hand breadth behind the corresponding kidney. A fold of peritoneum attaches them loosely to the sublumbar region. Embedded in the fibrous tissue of the substance of the ovary are little masses of epithelial cells from which the *graafian follicles* and eventually the *ova* develop. The functional value of the ovaries is connected with the formation of the ovum or female reproductive cell.

The **fallopian tubes** are two tortuous passages, about 10 inches long, that run between the layers of the broad ligaments. The ovarian end of the tube is fringed or fimbriated, and expanded into a funnel-like infundibulum for the purpose of catching the ova

[1] Azoux models have been found especially useful to give the student a clear conception of the structure and functions of the female generative organs.

when they are discharged from the surface of the ovary. The uterine end joins the womb. Their function is to convey the ova to the uterus.

The **uterus,** or **womb,** is a hollow, muscular organ situated in the abdominal cavity, from the walls of which it is suspended by the broad ligaments. It consists of two horns, the body, and the neck.

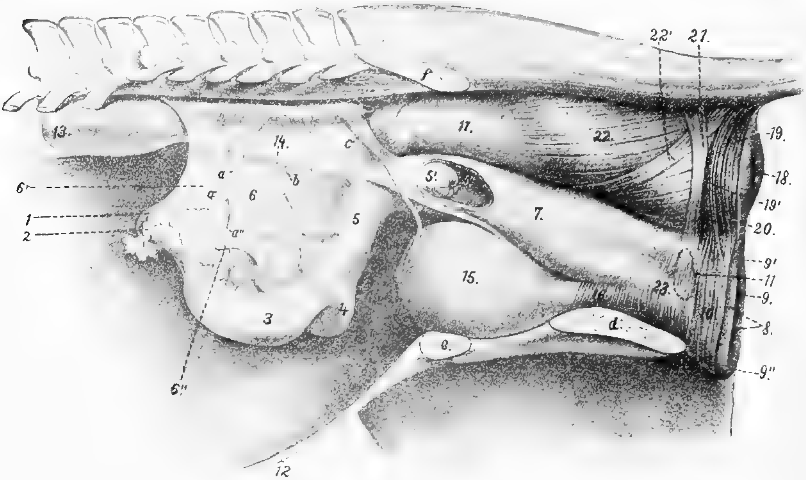

Fig. 34.—Genital organs of mare, lateral view: 1, Left ovary; 2, fallopian tube; 3, 4, 5, uterus; 5′, cervix of uterus, and 5″, os uteri, seen through window cut in vagina; 6, broad ligament of uterus; 6′, round ligament of same; 7, vagina; 8, 9, lips of vulva; 9′ and 9″, commissures of vulva; 10, constrictor muscle; 11, erectile gland; 12, wall of abdomen; 13, kidney; 14, ureter; 15, bladder; 16, urethra; 17, rectum; 18, anus; 19 and 19′, 20, 21, 22, 23, muscles; *a*, *a′*, *a″*, *b*, *c*, arteries; *d*, ischium; *e*, pubis; *f*, ilium. (After Ellenberger, in Leisering's Atlas.)

The horns are about 10 inches long and rounded at the anterior ends. The body is about 6 inches in length and cylindric in shape. The neck or cervix is the constricted part which joins the vagina. In the uterus the fetus is developed. The fetus is retained and nourished in the uterus until it is able to maintain a separate existence.

The **vagina** is a tubular organ which connects the uterus and the vulva. It is about 10 inches long, and is lined with mucous membrane thrown up into folds that are effaced when the fetus is

passed. The *os uteri* projects freely into the forepart of the vaginal cavity.

The **vulva** is the passage that continues the vagina backward, and forms the posterior opening of the genital canal. It is about 5 inches long. At its margin the mucous membrane, which lines the entire genital tract, meets the skin. On the floor of the vulva may be seen the external orifice of the urethra. The *clitoris*, a small erectile body, is lodged within the inferior commissure of the vulva.

The **mammary glands** are two in number and placed side by side on the middle line of the abdominal wall between the thighs. The teat or nipple is perforated by two or three orifices for the passage of the milk. The glands are composed of secreting cells which line minute acini that connect with small ducts. These ducts unite to form a number of tubes which drain into a central sinus or milk cistern. The function of the mammary glands is to secrete milk upon which the foal subsists for some months after birth.

That there is an intimate relationship between the activity of the mammary glands and the generative organs of the female there can be little doubt. Starling injected an extract of fetal tissues into the body of a virgin. This caused the mammary gland to become active and secretion of milk was actually produced. The experiment shows that in the fetus there is some substance, or property, which has a direct action upon the mammary tissue.

THE PHYSIOLOGY OF REPRODUCTION

Reproduction may be defined as the power to produce new but similar individuals. It requires the union of the *spermatozoön* from the stallion and the *ovum* from the mare. Before young horses can reproduce they must attain *sexual maturity* or *puberty*. Too early stud service may retard the development of the colt. He may be used on a few mares when two or three years of age, but should not be placed in regular service until four years old. The filly is usually sexually mature when one year old, but should not become a mother until she reaches the age of three years, or four if she is not precocious.

Heat, rut, estrum are expressions commonly applied to the period during which the mare exhibits a desire to mate. Mating will be permitted only during the period of estrum. This should occur between the fourth and the twelfth day after she

drops her foal. The ninth day seems to be the usual time for successful mating. If for any reason she does not conceive at this time, the period of estrum returns in twenty-one days and lasts three or four days. It is attended with characteristic signs of nervous or sexual excitement and swelling of the external genital organs.

Impregnation starts a rôle of rapid changes that are of great interest. The fertilized ovum quickly develops by the process of cell division, from a one-cell structure into a mass of cells, which arrange themselves in a definite manner to form three layers—the epiblast, the hypoblast, and the mesoblast. It becomes attached to the mucous membrane of the uterus through the formation of the *placenta*, by means of which it is furnished with nourishment from the mother. At the same time the uterus greatly increases in size and functional activity.

The **fetal membranes** consist of the amnion, allantois, and chorion. They are formed at an early date. Details of these structures may be found in works on anatomy, embryology, or obstetrics.

The **period of gestation** is the time which elapses between impregnation and the birth of the young. On the average, it is 336 days or approximately eleven months for the mare, but varies more in this animal than any other. Cases are recorded where normal foals have been born after having been carried but 300 days. On the other hand, the longest recorded gestation period is 400 days. As a rule, a mare carrying a colt-foal is pregnant several days longer than with a filly-foal. A mare with her first foal generally carries it for a shorter period than succeeding ones.

Signs of pregnancy begin to manifest themselves much later in the mare than in many other animals. Quick subsidence of sexual excitement follows impregnation. Failure of the usual rutting period is often the first indication of pregnancy. The mare becomes unusually quiet, docile, lazy, and shows a tendency to put on fat. Later the abdomen distends and may become pendulous. At this time a well-marked hollow may be seen in the flank. In advanced pregnancy the fetus may kick about in the uterus, after copious drinks of very cold water by the mother, so as to be distinctly visible.

Twin pregnancy in the mare results in abortion in about 90 per cent. of the cases at the eighth to tenth month. Usually it is

found that one of the two fetuses is considerably more developed than the other. When born alive they are quite small and nearly always fail to thrive.

Normal parturition is the act of giving birth to the fetus (now called the foal). It is often announced a week or more in advance by the following *signs of parturition:* A straw-colored fluid is seen to ooze from the teats of the swollen udder, where it dries and forms a wax-like mass over the orifices of the teat. About twenty-four hours before the foal is born the secretion of the udder takes on the appearance of normal milk. The mouth of the womb di-

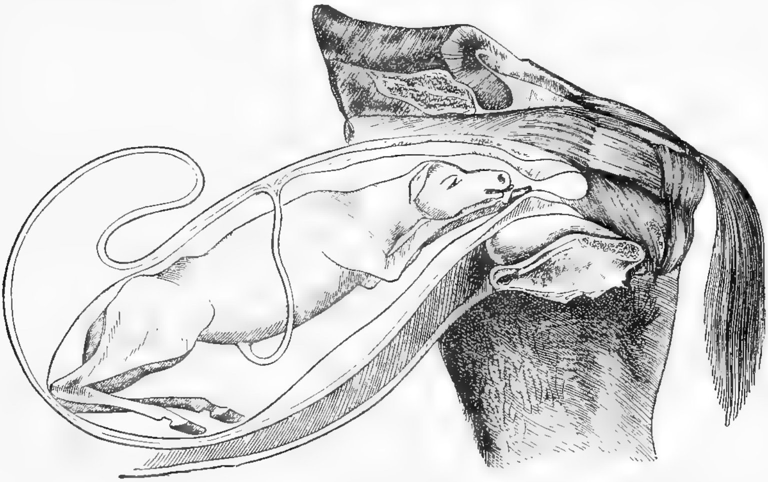

Fig. 35.—Position of the fetus at parturition. The normal, anterior presentation with the fore feet and head entering the genital canal. (Fleming.)

lates; the mare becomes uneasy and nervous as a result of the onset of labor-pains; the "water bag" or amnion filled with a clear fluid appears.

The foal should normally come with the fore feet first and the nose between the knees (Fig. 35), or may have the hind feet presented first. In either case it is wise to let nature take her course and not interfere, even if the process seems to be unusually slow. When mares are kept at light work, or have been given daily exercise throughout pregnancy, they generally have less difficulty at parturition than if standing idle for some weeks previous.

CHAPTER VII

THE CIRCULATORY SYSTEM

THE ORGANS OF CIRCULATION

THE *organs concerned with the circulation of blood and lymph* are the heart, the arteries, the veins, the capillaries, and the lymphatics.

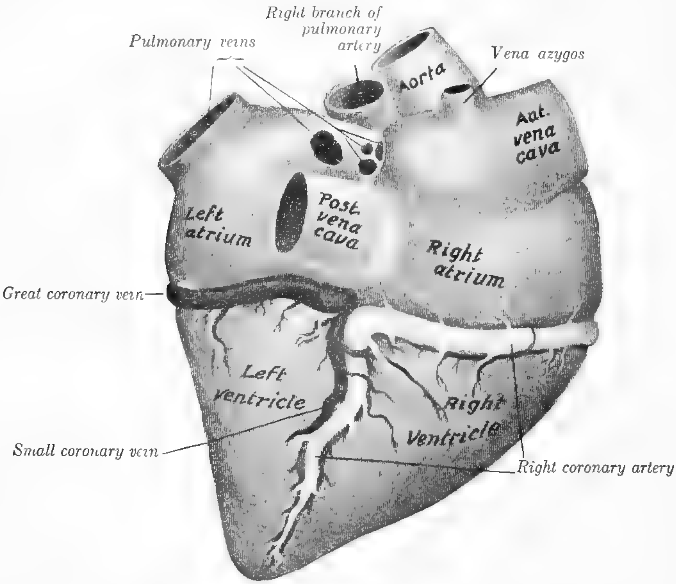

Fig. 36.—Right view of heart. The pericardium, epicardium, and subepicardial fat have been removed. Cardiac vessels are injected. (Sisson, Anatomy of Domestic Animals.)

The **heart** is the central organ of this system (Figs. 36, 37). It is situated in the thorax, between the lungs and opposite the third to sixth ribs. It is attached at the base to the large blood-vessels.

A horse of ordinary size has a heart of 7 to 8 pounds in weight. The *pericardium* is the fibrous sac lined with a serous membrane that surrounds the heart. In it is found a characteristic secretion, the *pericardial fluid*.

The **internal structure of the heart** is a nicely arranged pumping mechanism which propels the blood always in one direction. When

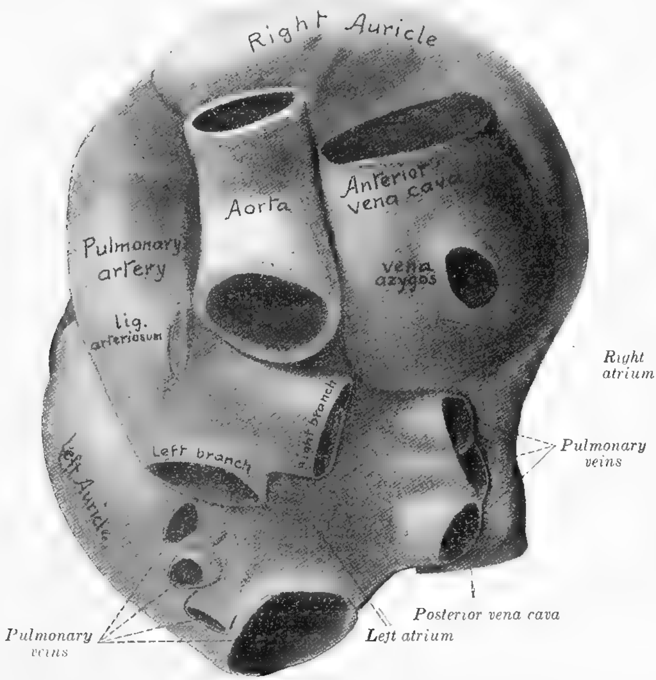

Fig. 37.—Base of heart, with large vessels. Photograph of specimen hardened *in situ*. (Sisson, Anatomy of Domestic Animals.)

the heart is opened by an incision for inspection it is seen to present four cavities—the right and left auricles and the right and left ventricles (Fig. 38). The two cavities of one side are partitioned off from those of the other by a septum of fibromuscular composition that keeps the pure and impure blood separated. The right anterior part of the base of the heart is formed by the **right auricle.**

It has orifices for the anterior and posterior vena cava, and in the ventral part the right auriculoventricular orifice, which leads into the right ventricle. This orifice is guarded by the tricuspid valve. By means of this and the other valves the blood is kept flowing in one direction. The **right ventricle** occupies the right anterior part of the ventricular mass, but does not reach the apex. It communicates with the pulmonary artery through the pulmonary

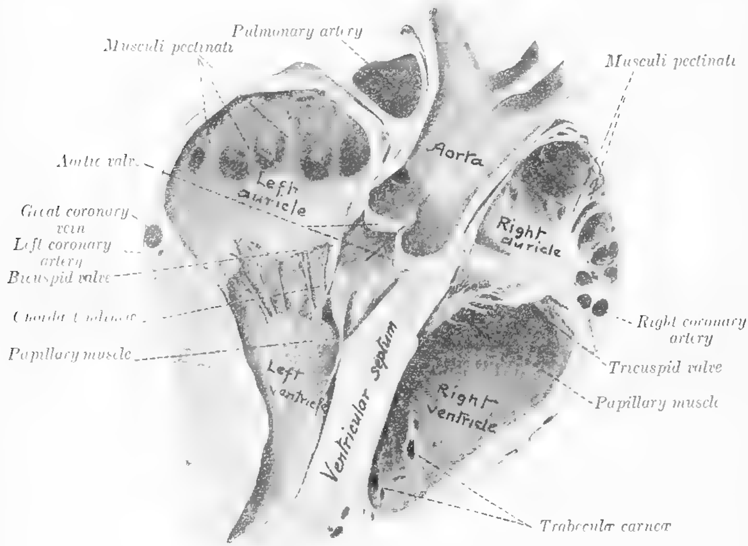

Fig. 38.—Section of heart. The section is cut nearly at right angles to the ventricular septum, and is viewed from the right. (Sisson, Anatomy of Domestic Animals.)

orifice, which is guarded by the semilunar valve composed of three cusps. The **left auricle** forms the posterior part of the base of the heart. Seven or eight pulmonary veins open into this cavity. Below it communicates by the left auriculoventricular orifice, which is guarded by the bicuspid valve, with the **left ventricle,** The latter discharges blood through the aortic orifice. This opening is guarded by the aortic semilunar valve similar to but stronger than the corresponding valve on the right side. All

cavities of the heart are lined with a glistening, transparent membrane, the **endocardium.**

The **arteries** have walls with considerable elastic tissue in them to allow expansion. They begin at the base of the left ventricle, as the **aorta,** the large vessel through which all the blood for the body passes (Fig. 39). For convenience the aorta is divided into thoracic and abdominal parts. From the former the **common brachiocephalic artery** arises close to the heart and is directed forward and upward. Branches from it supply the fore limbs, neck, and head. The abdominal part is termed the **posterior aorta.** It supplies branches to the walls and viscera of the abdominal

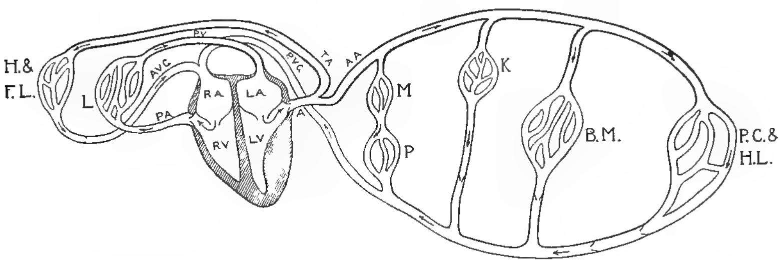

Fig. 39.—Diagram of the circulation: L, Pulmonary circulation; H. and F.L., circulation through the head and fore limb; M, mesenteric circulation; P, portal circulation; K, renal circulation; B.M., circulation through the body muscles; P.C. and H. L., pelvic cavity and hind limb; A.V.C., anterior vena cava; P.V.C., posterior vena cava; P.V., pulmonary vein; A, common aorta; T.A., thoracic aorta; A.A., abdominal aorta; R.A., right auricle; L.A., left auricle; R.V., right ventricle; L.V., left ventricle. The shaded vessels carry arterial blood, the others venous blood.

cavity, the body muscles, and the pelvic organs and limbs. The work of the arteries is that of a pipe-line, to convey blood from the heart to the various body organs.

Most arteries occupy protected situations and are straight in their course. When a vessel has to accommodate itself to the movements or contour of a part it makes a bend. Arteries communicate freely with one another, thus promoting equality of distribution and pressure and making good circulation possible even after a large vessel becomes obliterated.

The **veins** differ from the arteries in having much thinner walls. This causes them to collapse when not filled with blood. In many veins the internal coat is folded up to form valves, the free edges

of which are directed toward the heart to prevent the blood from flowing back. Veins are satellites of the arteries, and conduct the blood back to the heart from the tissues. The **anterior vena cava** returns the blood from the head, neck, and thoracic limbs to the heart. The **posterior vena cava** is the largest vein of the body, and conveys almost all the blood from the abdomen, pelvis, and pelvic limbs. Among its principal branches are the hepatic vein and the common iliac veins, which are formed by the confluence of the veins from the posterior parts of the body.

The **capillaries** are microscopic in size. In many cases they are not much larger in diameter than a red blood-corpuscle. They have extremely thin walls, often consisting of only one layer of cells. If all the capillary vessels were cut across and put together, the sectional area would be about seven hundred times that of the aorta. They function as connecting tubes between the arteries and veins. It is through the capillary walls that the interchange of gases between the blood and the tissues takes place.

The **lymphatics** consist of a number of well-defined groups of lymph-glands and connecting vessels which are closely related to the vessels carrying the red blood. Numerous very small radicals unite to form a great trunk, which commences in a reservoir known as the *receptaculum chyli*, located in the right sublumbar region. The *thoracic duct* leads forward from this and empties into the anterior vena cava, at the junction of the jugular veins near the base of the heart (see Fig. 24).

Lymph-glands are found in connection with every organ and group of muscles. They act as filters for the lymph, and are very important structures in maintaining the health. The bronchial lymph-glands are located at the bifurcation of the bronchi, and are usually discolored from the large amounts of very minute particles of carbon and dust which they have caught. In certain diseases, like tuberculosis, these glands early become infected with micro-organisms and greatly enlarge.

THE PHYSIOLOGY OF CIRCULATION

The **circulation of the blood** was not discovered until 1621, when Harvey showed how the blood flows and the heart functions. Before that time it was thought that the blood ebbed and flowed like the tide. In Fig. 39 is diagrammatically shown the course taken by the blood as it circulates through the system.

The **heart movements** may be best studied by stunning a small animal and exposing its beating heart. The series of movements through which the heart goes is termed a **cardiac cycle.** In the horse at rest it takes about two seconds to complete this cycle. At the beginning there is a contraction of the muscular walls of the heart by which the blood is forced out of the ventricles into the arteries. This movement is called systole. Immediately the heart muscles relax, which causes the auricles to dilate to their full extent and fill with blood from the several large veins emptying into them. This movement is termed diastole. When these movements are completed the heart pauses or comes to a rest, and the cardiac cycle is finished. Although very short, the resting period is sufficient to permit the heart to recuperate from its labor so as to be prepared for another similar series of movements.

An intricate group of nerves control the heart movements. They are derived from branches of the two vagi, each of which has a plexus near the base of the heart to influence the rate and force of its movements. One set of these nerves conveys impulses which stimulate the heart to increased activity, and are known as the **accelerator nerves.** Another set of nerve-fibers produce exactly the opposite effect and causes the heart to beat slower and with less force. These are termed **inhibitor nerves** from their action. In the walls of the blood-vessels are found nerves known as **vasoconstrictors** and **vasodilators.** They regulate the size of the vessels by acting upon the muscle-fibers in their walls. When a profuse supply of blood is required by the stomach, immediately after a meal, for example, to furnish the gastric glands which are extremely active at that time with substances to replace those secreted, the vasodilator nerves come into play. The result is a physiologic congestion of blood in the organ.

The **heart-beat** is the term commonly used to express the complicated series of changes just described. In healthy adult horses the heart beats from twenty-eight to forty times in a minute; in foals the beat is more frequent, varying from forty-five to one hundred times in a minute.

The **heart work** is the energy required to pump the blood through the organ. On account of the greater resistance in the peripheral arteries and capillaries than in their pulmonary counterparts, the work of the left heart has been estimated to be four times that of the right. The pressure under which blood is forced into

the aorta is equal to that of a column of blood 10 feet in height. Smith states that at each stroke about 2.25 pounds of blood are pumped into the aorta. From these figures we may compute that the work of the left ventricle with each systolic movement is equivalent to raising 22.5 pounds one foot. This should give some idea of the energy expended by the body in simply sustaining the circulation in a state of repose.

The pressure and rate of flow of the blood in the veins is very slight as compared with that in the arteries. They are aided by the following factors:

(1) *Respiratory movements*, as was explained in the chapter on Respiration, result in expansion and contraction of the thorax. During inspiration the blood is sucked into the large intrathoracic veins in much the same way that the air is into the lungs. The greater thickness of the walls of the arteries prevents in large measure this effect on them. During expiration the reverse action would take place, and the blood would be forced back into the tributary veins if they were not provided with valves. As there are no valves in the pulmonary veins and those opening into the right auricle, their contents run into the upper chambers of the heart.

(2) *Muscular contractions* result in a shortening of muscles. This brings about compression of the veins which lie between them and forces the blood from the smaller into the larger veins, the valves, as already stated, preventing any backward flow. The more rapidly a muscle contracts, the greater is the amount of blood circulating through it.

From these facts it is shown that good circulation is made possible only by exercise. When this is provided, the horse must breathe deeply and flex and extend the skeletal muscles, so that the blood is pumped out of the veins and the lymph is made to flow more freely in the lymph-vessels.

THE PROPERTIES OF THE BLOOD AND LYMPH

The **blood** is a red fluid, alkaline in reaction, with a peculiar odor thought to be due to a volatile fatty acid. Its specific gravity is 1060. When drawn from an artery the blood has a bright scarlet color. Venous blood is dark red in color, but on standing in the air readily becomes scarlet, due to the absorption of oxygen. Blood clots almost immediately when exposed to

external influences. The total amount of blood is about one-fourteenth of the body weight.

The **composition of the blood** is very uniform, being 66 per cent. plasma and 34 per cent. corpuscles.

The **blood-plasma** is the fluid part of the blood. It is nine-tenths water. The proportion of water and solids is little increased by drinking and only slightly reduced by thirst. Its constancy was explained when the functions of the kidneys were studied. Four different albuminous bodies form about four-fifths of the total solids of plasma. They are fibrinogen, nucleoprotein, serum-albumen, and serum-globulin.

The **clotting of blood** is due to the **fibrinogen.** This substance is transformed into *fibrin* by the action of the enzyme **thrombin.** Thrombin is derived from decomposing blood-plates, the minute extremely sensitive bodies present in normal blood. Freshly drawn blood may be defibrinated so it will not clot by whipping with a stiff wire or shaking with glass beads. The fibrin separates out as an elastic, fibrous mass.

The **blood-serum** is the clear liquid which is pressed out by the contraction of the blood-clot. It differs chiefly from the plasma in containing no fibrinogen. The color of serum is amber-yellow. Sodium chlorid is present in about 0.6 per cent. and is the principal inorganic constituent.

The **blood-corpuscles** are of two kinds, white and red. They are present in the proportion of about one to five hundred respectively. The *white corpuscles*, or *leukocytes*, are somewhat larger than the red. By virtue of their ameboid movement they have the ability to pass through intact vessel walls without causing harm. They are active agents in protecting the body against disease-producing micro-organisms. The *red corpuscles*, or *erythrocytes*, are biconcave disks, without nuclei, measuring $\frac{1}{4500}$ inch in diameter. They originate in the red marrow of bones, in the liver, and in the spleen. In very thin layers they appear yellow in color, but under ordinary conditions are red from the hemoglobin, a pigment, which they contain. **Hemoglobin** is a protein substance, making up about 90 per cent. of the solid part of the erythrocytes. It has the remarkable property of combining with oxygen in the lungs and of releasing this gas when it comes into a situation where there is a relative lack of the element, as is found in the tissues.

The **functions of the blood** may be summarized as follows: Blood carries oxygen from the lungs and food materials from the alimentary canal to the tissues; it conveys carbon dioxid and other products of activity from the tissues; it distributes heat and assists in equalizing the body temperature; it carries hormones from organ to organ; it neutralizes toxins and destroys bacterial invaders.

Lymph taken from the small lymph-vessels is a straw-colored fluid which has less tendency to coagulate than blood. That coming from the lacteals or receptaculum chyli is thicker and milky in appearance, due to the presence of the fats absorbed from the alimentary canal, and is termed *chyle.*

The presence of an excessive amount of lymph in a tissue results in a cool swelling which pits on pressure, as there is no circulatory movement in the lymph-spaces to bring it back.

Lymph contains numerous *lymph corpuscles,* or *lymphocytes.* It carries nutritive substances from the blood to the tissues and conveys away waste materials from them. It may be considered a middleman between the blood and the tissues.

An important function of the lymph is to lubricate. This is seen when an examination is made of the synovia of the joints and the pericardial, pleural, and peritoneal fluids, all of which contain considerable lymph and act to reduce friction.

CHAPTER VIII

THE NERVOUS SYSTEM

THE STRUCTURE OF NERVOUS TISSUE

A **nerve**, as seen in a piece of flesh, consists of an elongated cord made up of bundles of nerve-fibers and having the property of transmitting impulses. When studied with the aid of a microscope the **nerve-fibers** are found to be very delicate structures. They are of two kinds. The *medullated nerve-fibers* are fine filaments surrounded by a thick, white medullary sheath. This sheath is not continuous, but is interrupted at regular intervals so as to expose the neurilemma, a thin sheath directly surrounding the nerve-fiber. These medullated nerve-fibers are found in the nerves of the cerebrospinal system. The *non-medullated nerve-fibers* have only the neurilemma for a covering. They occur principally in the sympathetic nerve-trunks and plexuses. The **nerve-cell** is the unit of the nervous system. It is composed of a cell-body and one or more elongated processes. The **nerve processes** may be looked upon as outgrowths of the cell-body and are of two kinds—the axon or axis-cylinder process which becomes the nerve-fiber previously described, and dendrites or protoplasmic processes which branch out to bring the nerve-cell into definite relationship with others (see Fig. 1). The axons are extremely short in some organs, while in the limbs they reach from cells located in the spinal cord to the foot.

There are two distinctly different kinds of **nerve substance**—the white matter which is soft and contains about 70 per cent. of water, and the gray matter of brown color and softer consistency than the white substance containing over 80 per cent. of water and about 10 per cent. of proteins.

Ganglia are hard, gray masses found on the dorsal roots of spinal nerves and along the course of other nerves. They are composed largely of groups of cell-bodies.

Nerves terminate in the muscles, skin, and joints. The muscular branches are motor in function, the others sensory, but contain vasomotor fibers which control the caliber of the blood-vessels.

THE ORGANS OF INNERVATION

The organs comprising the nervous system may be arranged under: (1) The *central nervous system*, which includes the brain and spinal cord; (2) the *peripheral nervous system*, which comprises the

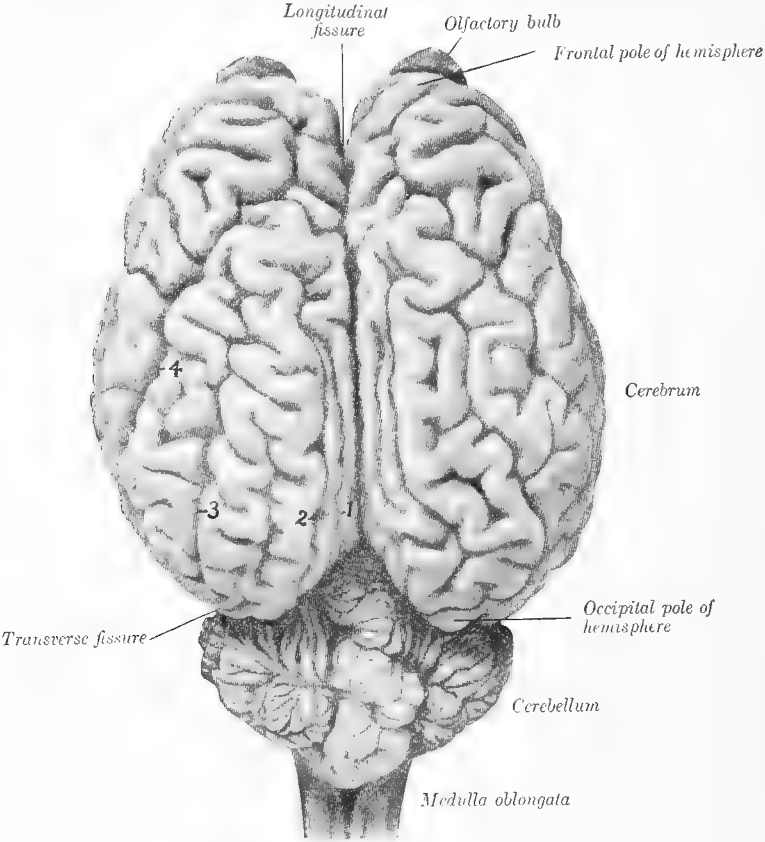

Fig. 40.—Dorsal view of brain. (Sisson, Anatomy of Domestic Animals.)

cerebral and spinal nerves with their ganglia; (3) the *sympathetic nervous system*.

The **brain** is the chief organ of the central nervous system (Fig. 40). It is located in the cranial cavity, and is composed of the

cerebrum, the cerebellum, the pons, and the medulla oblongata. Completely enveloping these parts and continued onto the spinal cord are three membranes or meninges.

The **dura mater** is the most external. It is in the form of a thick, tough, fibrous covering, bluish white in color. It lines the cranial cavity and extends backward to form a tube-like sheath for the spinal cord.

The **arachnoid** is the middle coat. It is a delicate serous membrane. Between its two layers is a space containing the cerebrospinal fluid. This fluid acts as a sort of water-jacket to take the jar and pressure off the sensitive nerve structures which it encloses.

The **pia mater** closely covers and adheres to both the brain and spinal cord. It contains numerous small blood-vessels for these structures.

The **cerebrum,** or large brain, occupies the anterior part of the cranial cavity. It is somewhat egg shaped, and is divided by a deep median fissure into two hemispheres. Externally, the surface is thrown up into well-defined convolutions. The outer part is composed of gray matter. In the center is found a core of white matter. An irregular cavity, termed the lateral ventricle, may be seen in the interior of each hemisphere. The olfactory bulb is the enlargement which projects from each of the two anterior poles.

The **cerebellum,** or small brain, is lodged in the posterior fossa of the cranium. It resembles a globe in shape and differs from the cerebrum in having a finer marked exterior. It is divided into the median vermis and two lateral hemispheres. For the most part it is composed of gray substance, but a core of white material resembling the branchings of a tree may be seen when the cerebellum is sectioned.

The **pons** (Varolii) is a bridge-like affair, which lies between the medulla and the cerebral peduncles. It connects the former with the cerebrum, and also the right and left portions of the cerebellum.

The **medulla oblongata** is the connecting link between the pons and the spinal cord. It differs from the brain proper in having the white substance externally.

The **cranial nerves** arise directly from the brain. There are twelve pairs, which have been numbered and named to identify them. The names indicate the functions or the parts to which they pass.

The *first* or *olfactory nerve* supplies the mucous membrane of

certain portions of the nasal cavity and has to do with the special sense of smell.

The *second* or *optic nerve* furnishes the eyes and has to do with the special sense of sight.

The *third* or *oculomotor nerve* supplies all except two of the muscles of the eyeball with motor power.

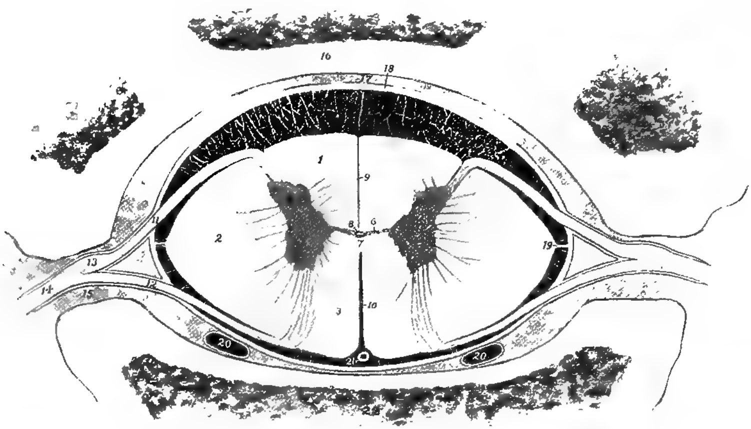

Fig. 41.—Cross-section of spinal cord: 1, Dorsal column; 2, lateral column; 3, ventral column; 4, dorsal horn; 5, ventral horn; 6, 7, commissures; 8, central canal; 9, dorsal septum; 10, ventral fissure; 11, dorsal nerve-root; 12, ventral nerve-root; 13, spinal ganglion; 14, spinal nerve; 15, intervertebral foramen; 16, arch of vertebra; 17, epidural space; 18, dura mater; 19, ligament; 20, 20, venous sinuses; 21, spinal artery; 22, body of vertebra. The outer part of the arachnoid and pia mater are not shown. (Sisson, Anatomy of Domestic Animals.)

The *fourth or trochlear nerve* is the smallest of the cranial nerves. It ends in the posterior parts of the superior oblique muscle of the eyeball.

The *fifth* or *trifacial nerve* is the largest of the series. It has both motor and sensory fibers for different parts of the face and mouth and has a very important function to perform.

The *sixth* or *abducent nerve* supplies the retractor muscles of the eyeball.

The *seventh* or *facial nerve* is responsible for the movements of

most of the muscles of the face. It consists of both motor and sensory parts.

The *eighth* or *auditory nerve* goes to the ear, and has to do with the special sense of hearing.

The *ninth* or *glossopharyngeal nerve* is mixed in character, and conveys both motor and sensory impulses to the tongue and pharynx.

The *tenth, vagus* or *pneumogastric nerve,* is a very large nerve-trunk with both motor and sensory fibers that supply the stomach, heart, lungs, trachea, pharynx, and related organs.

The *eleventh* or *spinal accessory nerve* has motor fibers only.

The *twelfth* or *hypoglossal nerve* is purely motor and innervates the muscles of the tongue.

The **spinal cord** is situated in the vertebral canal, and extends from the medulla, which it continues, to about the middle of the sacrum. Forty-two pairs of *spinal nerves* connect with the sides of the spinal cord. The cord is enlarged where the nerves to the limbs are connected. On cross-section a dorsal median septum and a ventral median fissure are seen, also the central canal of the cord (Fig. 41). White matter surrounds a core of gray matter. The latter is arranged in the form of a capital H. Dorsal and ventral gray horns, which give rise to nerve-roots with the same names, are plainly visible.

The **sympathetic nervous system** is composed of two chains of ganglia which are located one on each side of the vertebral column, external to the spinal canal. At intervals communicating branches join this system with the central nervous system. There are particular ganglia and plexuses for the main groups of visceral organs. The most important is the **solar plexus,** which is situated on the dorsal wall of the abdominal cavity in contact with the aorta.

THE PHYSIOLOGY OF THE NERVES

The **function of the nerve-cell** is to act as a center for the nutrition of the nerve-fibers proceeding from it. It is acted upon by stimuli from without. The stimuli are conducted to it by the nerve-fibers. In the absence of such stimulation it has the power of independent or automatic action.

The **function of the nerve-fibers,** according to Starling, is simply that of conducting impulses from the sense organs at the

periphery to the central nervous system and efferent impulses from this to the muscles and other of its servants. In order to perform its function the nerve-fiber must have direct continuity with its nerve-cell.

The rate of conduction along a nerve-fiber, although very rapid, may be measured by an especially designed electromagnetic apparatus. A nerve of a certain muscle is stimulated at two points a known distance apart, and the time which elapses between the contraction of each is determined. Many measurements have demonstrated that an impulse passes along a nerve at a rate exceeding 100 feet in a second; so the longest paths in the body are traversed almost instantaneously.

The direction in which a nerve-fiber conducts may be determined by either cutting it or stimulating it and noting the result of the stimulation. Nerves which conduct impulses from the central nervous system outward are termed "efferent" nerves. They always belong to the ventral nerve-roots of the spinal cord. Nerves conducting in the opposite direction are known as "afferent" nerves and belong to the dorsal roots of the gray matter of the spinal cord.

Efferent nerves may either increase the activity of the parts which they supply or diminish or inhibit activity. The former class are termed "augmentor" nerves; the latter, "inhibitory" nerves. **Augmentor nerves** are divided into the *motor nerves,* which act on muscles; *secretory nerves,* which act on secretory glands, and *vasoconstrictor nerves,* which narrow the lumen of the blood-vessels. **Inhibitory nerves** are divided in a manner similar to the above into *musculo-inhibitory, secreto-inhibitory,* and *vaso-inhibitory nerves.*

Afferent nerves conduct impulses from the outer parts of the body to the central nervous system. They are divided into *sensory nerves,* which when stimulated cause sensations, and *excito-reflex nerves,* which give rise to the so-called reflex actions. These two are not distinct from each other, for at one time they will cause a sensation and at another time a reflex action without sensation.

The **function of the cerebrum** is to govern both consciousness and intelligence. Removal of this portion of the brain does not interfere with eating or sleeping, but the animal cannot associate its sensations. There are certain areas which can be mapped out on the cerebrum of the dog for movements of the eye, the vocal

cords, and movements in response to commands. The human brain has been mapped out in great detail, with results which show that the intricacies of it are almost beyond conception.

The **function of the cerebellum** is to act as the center for nerves of co-ordination like those in the semicircular canals of the ears, and to the muscles, tendons, and joints that are concerned with movements and postures of the body. When its physiologic activities are interfered with the animal reels when it moves and acts as if intoxicated. A serious injury to the cerebellum may cause the patient to walk or spin around in a circle or turn somersaults.

The **functions of the pons and medulla** are closely related. These parts are remarkable for the great number of reflex centers they contain—centers for the heart movements, respiration, swallowing, vomiting, and for closure of the eyelids are located in these parts of the brain.

The **functions of the spinal cord and nerves** are varied. With the exception of a part of the face all of the body is endowed with sensory nerve-fibers from the spinal cord. The nerve-fibers of the ascending and descending tracts in both the white and gray matter of the cord conduct sensations to and from the brain, and, in conjunction with the spinal nerves, from one part of the body to other parts. This latter function is dependent upon the reflex centers which are located at different points in the spinal cord. In the lumbar region there are special reflex centers for impulses from the bladder, rectum, and the sexual organs.

A **reflex action** is one produced independently of the will. It is always of a distinct purposeful character, and is made possible by a neural arc in the spinal cord. The mechanism involved consists of sensory fibers, to conduct to the nerve-center in the spinal cord, the cross-over or connecting fibers, and the motor fibers to carry the impulse to the muscles. Hough and Sedgwick say that it is a common error to suppose that all actions which are not called forth by the will are reflex. The essential feature of a true reflex is the more or less direct action of the afferent impulses on efferent nerve-cells, and not merely its non-volitional character. There are, in fact, involuntary actions in which the efferent nerve-cells are directly stimulated not by afferent nerve-cells, but by the condition of the blood or in other ways. Such actions are not reflex, though they may be either involuntary or

unconscious, or both. They are known, in general, as *automatic actions*.

The **functions of the sympathetic system** are of two kinds: First, it serves to transmit stimuli to the heart and other involuntary muscles and glands. Second, it conducts impulses from the viscera to the cerebrospinal system under which it normally works. In an emergency it has the ability to work independently of the central nervous system to carry out peristaltic movements in the hollow viscera.

CHAPTER IX

THE EAR, THE EYE, THE SKIN, AND THE FOOT

THE EAR

THE *ear* has to do with the sense of hearing. It consists of three parts:

The **external ear** comprises three cartilages, the largest of which is the trumpet-shaped conchal cartilage which determines the shape of the ear and is covered by thin skin. A fine, flexible ear is an evidence of breeding.

The **middle ear** is called the drum on account of the thin membrane which separates it from a tympanic air-containing cavity. Across it a chain of three bones is stretched. These bones transmit the sound-waves from the outer to inner ear. They are named the malleus, from its resemblance to a hammer; the incus, which is shaped like an anvil; and the stapes, which is stirrup shaped. A connection is made between the middle ear and the pharynx by means of the eustachian tube to equalize the pressure of air upon the ear-drum.

The **internal ear** is composed of a series of chambers in the substance of the temporal bone, soft structures, and fluids. In it are found the ramifications of the auditory or eighth cranial nerve, which has to do with the reception of sound-waves. The actual organ of hearing is the cochlea, a bony structure similar in shape to a snail's shell.

The **function of the ear** is to record the sensations of sound. When sound-waves reach the ear-drum they set it in motion. In turn, the latter causes the chain of ossicles to vibrate and the auditory nerve transmits the impulses to the auditory center of the brain.

THE EYE

The *eye* is the organ of vision. It comprises the eyeball, the optic nerve, and the accessory structures—the eyelids, the conjunctiva, and the lacrimal apparatus.

The **eyelids** are the most exposed parts. They are movable folds of skin on the margins of which the eyelashes are borne. The **third eyelid, haw,** or **nictitating membrane** is an important part of the eye of the horse. It consists of a plate of cartilage covered by a fold of the conjunctiva. By frequently closing and opening the eyelids the horse removes dust particles from the cornea and keeps the eye in working order.

The **conjunctiva** is the mucous membrane which lines the eyelids and is reflected on to the anterior part of the eyeball. It is normally of a bright pink color.

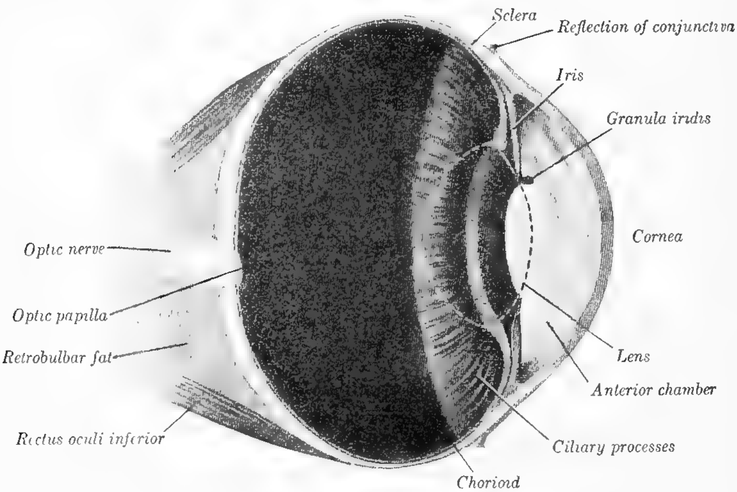

Fig. 42.—Vertical section of eyeball. The contour of the crystalline lens is dotted. (Sisson, Anatomy of Domestic Animals.)

The **lacrimal apparatus** is made up of the *lacrimal gland*, which secretes the tears; and the *lacrimal duct*, which carries the overflow of fluid to the nasal cavity. Tears assist in removing the small particles of dirt from the eyeball and keep it moistened.

The **eyeball** is composed of the segments of two spheres of different sizes (Fig. 42). The anterior is the cornea; the posterior, the sclera. The *cornea* is transparent, oval in outline, and fits into the sclera like a crystal does into a watch. The *sclera*,

or white of the eye, is the thick, tough membrane which supports the *choroid*, or colored layer, the *ciliary body*, and the *iris*.

The **chambers of the eye** are two in number. The *anterior chamber* is enclosed in front by the cornea and behind by the iris. The *posterior chamber* communicates with the anterior through the *pupil* or opening in the iris, and is much the smaller. An *aqueous humor* of clear, water-like consistency fills these chambers.

The **refractive media of the eye** consist of the *vitreous humor*, a semifluid, transparent substance occupying about four-fifths of the whole interior of the globe; and the *crystalline lens*, a biconvex structure composed of concentric layers of tissue. It is situated just behind the pupil.

The **optic nerve** enters the eyeball from the rear and expands to form a very delicate and extremely sensitive membrane known as the *retina*.

The **function of the eye** is to form an image in its fluids so that the animal may better adjust himself to his surroundings. The retina is the sensory surface which responds to stimulation by light. Any impulses which it receives are transmitted by the fibers of the optic nerve to the visual center in the cortex of the brain. The iris regulates the amount of light which passes to the retina by dilating and contracting the pupil. The refractive media are for the purpose of bringing rays of light to a focus on the retina. They have the power of accommodation by which it is possible to see objects at close range as well as at a great distance. Each eyeball is afforded varied combinations of movements by special voluntary muscles that are capable of perfectly balancing the eyes for binocular vision.

THE SKIN

The *skin* is the covering tissue which acts as a mechanical protection to the surface of the body. It consists of two main layers, the epidermis or scarf skin being the outer and the dermis or true skin the inner. The **epidermis** is composed of several layers of cells, the outer of which are horny, scale-like, and fall off in the form of dandruff when horses are groomed. It contains the coloring-matter or pigment of the skin. The **dermis** is a vascular structure containing a network of white fibrous tissue with some elastic fibers. Its inner face adheres closely to the strata of fat tissue which lies beneath it. Its external face is perforated by

openings for the hairs and the ducts of the sebaceous and sweat-glands, which lie in the lower layers of the dermis.

In health the skin feels pliable and elastic, and is easily movable upon its underlying tissues. When a fold is drawn up between the fingers, it quickly regains its normal position when released.

The **sebaceous glands** have small openings into the hair follicles. They secrete an oily substance known as *sebum*, which serves to keep the hair glossy and the skin soft and flexible.

The **sweat-** or **sudoriparous glands** discharge sweat directly upon the surface of the skin. *Sweat* is a watery, sherry-colored fluid, salty to the taste, of strong alkaline reaction, and characteristic horse-like odor. Besides water it contains inorganic salts, fatty acids, and waste products. It serves to keep the skin moist and in good condition, to remove waste and poisonous or irritating matters, and to regulate the body temperature by evaporation.

Appendages of the skin comprise the hairs, the chestnuts and ergots on the legs, and the hoofs of the feet.

The *hairs* are a modification of the epithelium. Each hair has a bulbous root springing from the hair-follicle, an involution in the skin, into which one or two sebaceous glands empty. Involuntary muscle-fibers are found at the base of the hairs, which cause them to rise or "stand on end" under the influence of cold. Hair grows by constant additions from the skin to which it is firmly attached. The growth is regulated by the environment of the horse. The hair coat is changed twice a year, once for a heavy and once for a light coat. Proper food and care hasten the shedding of the hair; opposite conditions tend to postpone it. Hair corresponds in color to the pigment in the skin which it covers. As the animal grows old there is a tendency for the hair to turn gray, especially about the head. The color of the hair which comes in over a wound is often white. The foal is generally quite different to its color at maturity.

Horsemen like to see a glossy coat and fine, short hair, as these are indications of good condition, which means ability to utilize feed to the best advantage. A coarse hair denotes a coarse skin. Horses running at pasture show a long, lusterless, rough coat from lack of grooming. The long hair on the legs of draft horses is termed "the feather." When "silky" it is a sign of good quality in both the skin and bone.

The *chestnuts* and *ergots* are callus-like, horny, growths. The

former are usually regarded as vestiges of the first digit. They are of variable form and size and occur on the inner surface of the forearm, and on the lower part of the inner face of the hock. The term "ergot" is applied to a small mass of horn which is situated in the tuft of hair at the fetlock. It is the vestige of the second and fourth digits of extinct horses, and hence is absent in cases in which these digits are developed.

THE FOOT

The *foot* is a most important structure (Fig. 43). The utility of the horse may be largely measured by the fitness of the foot for

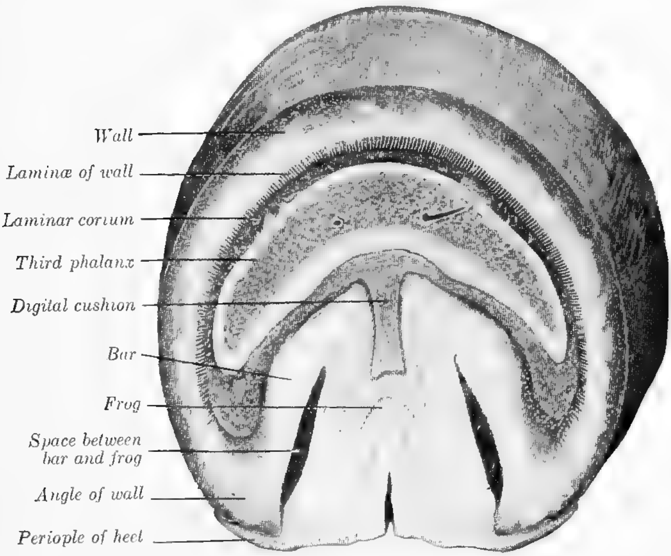

Fig. 43.—Cross-section of foot, cut parallel with coronet. The wall appears much thicker at the angles than it actually is, because it is cut very obliquely. (Sisson, Anatomy of Domestic Animals.)

service. All the parts of the foot to be described represent counterparts of the skin.

The different structures comprising the foot may be grouped into: (1) *Organs which give the foot elasticity;* (2) *sensitive organs of the foot;* (3) *the protective organ of the foot.*

The **plantar cushion** is the chief elastic organ. It is a buffer of fibro-elastic tissue, situated between the horny frog below and the deep flexor tendon above.

The **lateral cartilages** comprise the other two elastic organs. They were described with the bones of the foot.

The **pododerm,** or **foot-skin,** is the collective term used for the sensitive organs of the foot. It covers the foot in a manner similar to that in which the skin envelops other parts of the body, but is relatively thicker. Instead of producing the epidermis and hair, it gives rise to the horn. When exposed it is found to be a red, sensitive tissue, and is commonly called the "quick." For convenience the pododerm is divided into the perioplic band, the coronary band, the sensitive laminæ, the sensitive sole, and the sensitive frog. Each of these parts secretes a corresponding horny part for protection.

The **perioplic band** is a narrow band of flesh running around the hoof-head just above the coronary band. From the fine villi on the surface of this band the *periople*, or hoof varnish, is secreted. This substance is thin, hard, and brittle when dry, its function being to hold moisture and keep the hoof soft and elastic.

The **coronary band** is a bolster-like structure, about $\frac{4}{5}$ inch wide, which extends entirely around the foot from the bulb of one heel to that of the other. It lies in a groove at the upper border of the hoof. From it the horny wall grows.

The **sensitive laminæ** consist of a large number of fleshy leaves, longer at the toe than at the heel, that correspond with laminæ of the wall.

The **sensitive sole** covers all the lower surface of the foot except the plantar cushion. It is covered with villi which secrete the horny sole.

The **sensitive frog** covers the lower surface of the plantar cushion and secretes the horny frog.

The **hoof** is the protective organ of the foot. It is the horny case or box enclosing the sensitive structures. Numerous minute fibers resembling hairs firmly bound together make up the hoof. From the standpoint of horseshoeing it is next in importance to the shoe; from that of utility it is paramount, as it is a reliable guide to the condition of the important parts which it covers. As the hoof is developed with the skin at the hoof-head, it is readily

understood why the two correspond in color. The hoof is divided into the wall, the sole, and the frog (Figs. 44, 45).

The **wall** is all that portion which is seen when the foot rests upon the ground. It gives the foot its form. The horn is very hard and solid and affords adequate protection to the sensitive structures beneath it. At the toe the wall is highest; from this point backward it gradually decreases in height, passes around the bulbs of the heels, and turns forward and inward to form the *bars*, which are finally lost in the edge of the sole near the apex of the frog. It thus forms at each heel an angle known as the *buttress*. Each buttress encloses a branch of the horny sole. The inner sur-

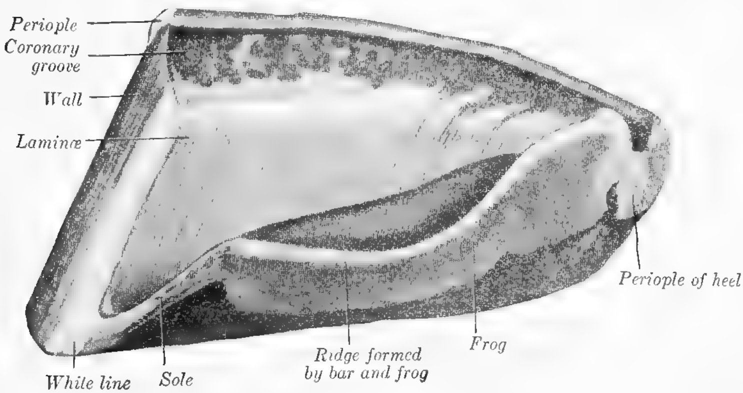

Fig. 44.—Half of hoof, internal surface. (Sisson, Anatomy of Domestic Animals.)

face of the wall presents about six hundred horny leaves or laminæ which dovetail with the sensitive laminæ. A firm union is thus made, so that it is very difficult to separate the two. The upper edge of the wall is thin, flexible, and grooved for lodgment of the coronary band. The lower edge is called the "bearing surface," and is the part to which the shoe is fitted. At the toe the wall is thickest; as the quarters are approached it gets considerably thinner. It requires about twelve months for the wall to grow from the coronet to the ground at the toe, six to eight months at the quarters, and three to five months at the heels.

The **sole** is that horn nurtured by the sensitive tissue covering the sole surface of the coffin bone. It is divided into a body and

two branches and is crescent shaped. The sole should be distinctly vaulted. The horn of the sole is friable, brittle, and flaky. Flakes of dead horn gradually loosen and fall off. They should never be pared away with the knife. The outer border of the sole is beveled to correspond to the slope of the wall. It does not come directly in contact with the wall, but is separated by the *white line* of soft

Fig. 45.—Right fore hoof, ground surface: 1, Wall at toe; 2, laminæ of wall; 3, angle of wall; 4, bar; 5, sole; 5′, angle of sole; 6, white line (junction of wall and sole); 7, point of frog; 8, median cleft of frog; 9, 9, lateral clefts of frog; 10, 10, bulbs of hoof at the heels. (Sisson, Anatomy of Domestic Animals.)

horn. This line is of great importance to horseshoers, as it indicates the thickness of the wall. The inner border of the sole is a V-shaped notch which joins the bars except at its narrow part where the frog articulates.

The **frog** is an exact mold of the plantar cushion which it covers. It is a wedge-shaped mass, filling up the angle between the bars

and the sole, and extending considerably below these on the ground surface of the foot. Thus the frog receives the greatest amount of concussion, but it is seldom injured, for its horn is of very elastic consistency. The inner surface presents a well-marked *median cleft.* The superior surface has the "frog stay" which aids to bind the frog to the overlying parts.

The **physiologic movements of the hoof** are due to the fact that the foot is never at rest. The constant shifting of the weight, even when standing, changes the shape of the hoof. Adams has grouped these changes of form into (1) An expansion or widening of the whole back half of the foot from the coronet to the lower edge of the quarters. This varies between $\frac{1}{15}$ and $\frac{1}{12}$ inch. (2) A narrowing of the front half of the foot, measured at the coronet. (3) A sinking of the heels and a flattening of the wings of the sole. These changes are more marked in the half of the foot that bears the greater weight. In order to keep the foot healthful these movements must be maintained with regularity. When the horse is allowed to stand in the stable for days without exercise the results are bound to show in the feet as pathologic changes.

PART II

COMMON DISEASES OF THE HORSE

CHAPTER X

DISEASE IN GENERAL

DEFINITION AND CLASSIFICATION OF DISEASE

Disease includes all those variations from the normal which impair more or less the adaptability of the animal to its surroundings. Disease modifies existing body structures, but does not add new parts to the body.

Synonyms of the term "disease" in common use are *malady*, *affection*, and *complaint*. The word *abnormality* is applied particularly to a structural modification like a bone spavin. A congenital fault, like that of the teeth, shown in Fig. 63, is called a *malformation* or *defect*. The term *deformity* is used for an acquired structural fault; for example, atrophy or "sweeny" of the shoulder muscles.

Pathology is that branch of medical science which has to deal with all phases of disease except the treatment. It consists of a study of the modifications in functions and changes in structure caused by disease.

Classification of disease on a satisfactory basis has been possible only within the last thirty years, or since the study of bacteriology has revealed the causes of many heretofore obscure diseases. Up to that time most diseases were supposed to be due to a miasma, the mist arising from marshy places. On the strength of this recent knowledge we have come to recognize two great classes of disease—the non-infectious and the infectious. A division into non-communicable and communicable diseases is helpful in studying methods of transmission and control, and will be followed when the individual diseases are considered.

In many treatises diseases are classified, on an anatomic basis, as respiratory, nervous, urogenital, etc., in a manner similar to that followed in classifying the different systems of body organs. A simple grouping of diseases according to their manner of occurrence follows: (1) **Sporadic disease**—one which occurs in isolated cases or at rare intervals, for example, glanders. (2) **Epizoötic disease**—one which occurs in many animals or over a large area at the same time, like influenza. (3) **Enzoötic disease**—one which exists among small numbers of animals or within a restricted area, like heaves.

It is customary to refer to diseases according to their duration, as: (1) **Acute disease**—one which runs a rapid course of a few days, and comes to termination within a time that experience has shown to be fairly constant for that disease, like azoturia. (2) **Subacute disease**—one which runs a slower course than an acute disease, and lasts for two or three weeks, like glanders in the mule. (3) **Chronic disease**—one which runs a prolonged course of from four weeks to an indefinite period of months, or years, or decades, like tuberculosis. In chronic diseases there is no regularity of events in the symptoms which follow. We cannot say when the disease began or when it will end.

THE CAUSES OF DISEASE

It is evident that there must be many different causes of disease. In a broad sense, all diseases are caused by influences which originate outside the body. For example, faulty body conformation, a hereditary defect, would seem to be of internal origin, but this alteration in conformation must have had its external cause in some previous generation as the result of external influence.

The causes of disease may be conveniently grouped as predisposing and determining causes. One of these may be as extensive in exerting damage as the other.

(A) **Predisposing causes of disease** are remote or distant causes which produce a disposition toward disease; that is, prepare the patient for easier attack by the determining causes. For the most part, the predisposing causes exert their influence from the outside. It should not be understood, however, that all external influences are predisposing causes, as reference to those classified

under Determining Causes on a later page will show. Chief among the predisposing causes of disease are climate, heat, cold, food, water, air, exercise, work, and auto-intoxication.

Climate plays an important part in causing disease. A warm, moist climate is most favorable for the development of infectious diseases and those caused by animal parasites. A cold, dry climate gives conditions most conducive to the preservation of health, as it is antagonistic to the growth of germ life.

Heat is not dangerous unless the temperature of the atmosphere rises above 101° F., the normal for the body of the horse. Higher temperatures predispose to heat- and sun-stroke. If the animal sweats freely, and the excretion is readily evaporated, much higher degrees of temperature can be borne without harm.

Cold acts either locally or generally. When excessive it leads to frost-bite, which may be followed by death of the affected part. Protracted exposure to cold reduces the resistance and predisposes to catarrhal affections of the respiratory organs.

Food may be either a predisposing or direct cause of disease. When fed to excess it causes distention of the stomach and may even lead to rupture of that viscus. Gases are formed in the stomach and intestines from decomposing and fermenting foods. When the natural channels of escape are unable to take care of these gases, bloating results. Insufficient food causes lack of nourishment, with loss of strength, weight, and resistive power to disease. When the diet is too dry and highly nutritious it may cause constipation and torpidity of the liver and other organs. If too laxative, it will produce a flaccidity of the whole system and a general lack of vigor.

Water at the wrong time or at too long intervals may be harmful and cause digestive disturbances. Too little water gives insufficient fluidity to the food mass and leads to constipation. Animals deprived of water for a long time lose their appetite for solid food, and often develop a persistent diarrhea when water is again provided. Water is a frequent source and conveyor of disease, particularly of those forms that are due to internal animal parasites.

Air may carry infection from place to place. Epizoötics may be spread by high winds or infection carriers, like winged insects, carried by winds over large areas. Contaminated air, particularly when combined with poor ventilation, is responsible for the rapid

dissemination of disease in large stables. Attention was called to the air requirements of the body in the chapter on Respiration. An adequate ventilating system should be provided in the stable to insure a supply of fresh air at all times.

Exercise, when excessive, leads to fatigue and tissue destruction. Lack of exercise interferes with the blood-supply and nourishment in all parts of the body, and predisposes to azoturia, swollen legs, colic, etc.

Work plays a part in acquiring disease. Horses which are worked in places where many impurities exist in the atmosphere are subject to bronchitis, pneumonia, and other diseases of the respiratory organs. Draft horses used for years on the pavements of city streets acquire a predisposition to certain forms of lameness.

Auto-intoxication is a self-poisoning due to an accumulation of poisonous substances in the body. In most cases irregularities in digestion or elimination are responsible. When the digestive system fails to dispose of the by-products promptly, they are absorbed and act as poisons to other organs. The kidneys, which normally throw off certain waste products, are placed under too great strain. This results in an inflammation of the mucous membrane lining their tubules and interferes with their function. In the horse, azoturia is a notable example of auto-intoxication. Proper feed, care, and exercise will prevent and relieve this serious affection.

(B) **Determining causes of disease** are those that operate directly to produce disease. They act more efficiently if some predisposing cause has first been operative. In fact, it is doubtful if predisposing causes in moderate action and without too great persistance are capable of producing a distinct anatomic or functional fault of sufficient importance to be termed "disease." However, if the cause persists in operating it is certain to lead to actual disease. Determining or exciting causes of disease deserving mention are traumatisms, poisons, and parasites.

Traumatisms are any form of injury which produce lesions or wounds in the tissues of the body. They will be more fully discussed in the chapter on Wounds.

Poisons are substances that destroy life or impair the functions of one or more of the body organs. They may be separated into three classes, as follows—(1) *animal poisons,* like snake venom, which is highly toxic; (2) *vegetable poisons,* like opium and strychnin; (3) *mineral poisons,* like arsenical salts, caustic soda, silver

nitrate. Some poisons exert their destructive influence by causing a coagulation of the tissue-juices; others, by causing a liquefaction of the tissue-cells.

Animal parasites may transmit as well as cause disease. In later pages the harmful influences exerted by them will be shown. It has been proved that some diseases can be absolutely controlled and prevented if proper measures are taken to destroy the parasites which carry the infectious organisms.

Vegetable parasites include certain molds, rusts, and smuts. They are found infesting grain and forage which has been improperly harvested or stored. When conditions have been favorable for their growth they may cause that fatal disease of horses known as forage-poisoning.

Bacterial parasites are the cause of all infectious diseases. However, all bacterial parasites of the body are not pathogenic—that is, disease-producing in their action. Many micro-organisms exert a distinctly beneficial influence in the body and serve the host in keeping down the growth of harmful bacterial parasites. When bacteria infect the body they may remain at or near the site of infection; they may spread through the tissues by direct growth, or be carried by the body fluids to distant parts; they may multiply in the blood, or they may set up metastatic infections by forming local lesions in other parts of the body. Disease may be produced by the action of their toxins or poisons, or by the mechanical interference which their presence exerts.

NATURAL RESISTANCE AGAINST DISEASE

Horses and all other animals are constantly exposed to infections with the various forms of parasites just mentioned, many of them in a high state of virulence. Nature has provided a number of very efficient defensive mechanisms to protect the body against these micro-organisms. It is through these agencies that our animals escape disease, even after prolonged exposure.

The protection afforded the body against disease may be due to any one or more of the following defences:

I. **The Antibodies in the Blood-serum.**—These substances are similar in character to enzymes and appear to act in a chemical manner. They are stimulated to production through the introduction of foreign substances. They prevent bacteria from multiplying and neutralize the poisons produced by them. The major-

ity of infections are brought under control by the action of antibodies before they have done any harm, as the number of infecting organisms is usually small. On the other hand, if the invasion of bacteria is great the antibodies are not capable of overcoming them, and disease results either from the mechanical interference produced by the organisms or from a poisoning of the body by the noxious bacterial toxins which circulate with the blood to all parts of the body. Certain organs are more susceptible to the action of these poisons than others and give way to them much quicker. This is nicely illustrated in cases of tetanus, where the organs of the nervous system are the first to show the effects of the toxin produced by the tetanus bacilli. Among the most useful antibodies are *antitoxins*, which neutralize the harmful effect of bacterial toxins; *agglutinins*, which cause bacteria to clump or agglutinate and lose their motility; *precipitins*, which precipitate certain organisms under favorable conditions.

II. **The Phagocytes or White Cells of the Blood.**—These cells are capable of passing through intact walls of the blood-vessels. They collect at the seat of infection and take up and destroy the bacteria that are attempting to invade the tissues. As active agents in aiding the body in the fight against foreign invaders they are very important.

III. **The Secretions of Certain Glands.**—These possess marked bactericidal properties. A good example is seen in the germicidal action of the acid gastric juice.

IV. **The Elevation of the Body Temperature.**—This reaction follows an invasion with bacteria, and assists in eliminating them by oxidation or by making their surroundings unsuitable for growth.

V. **The Intact Skin and Mucous Membranes.**—Both these structures belong to the epithelial tissues, and are capable of excluding most micro-organisms and of serving as efficient external defences against invaders from the surfaces of the body.

Immunity is the general term used to express all of the factors concerned with the natural resistance of the body against disease which have just been mentioned. It may be defined as that condition in which an individual or a species of animals exhibits resistance to an infection for which other individuals or other species show a greater or less degree of susceptibility. So far as is known, immunity is possible only against those diseases that are caused by

micro-organisms or viruses. Immunity may be either natural or acquired.

Natural immunity is an inherited characteristic. It may be an attribute of the species, the race, or the individual. Hog-cholera, a typical infectious disease, will nicely serve to illustrate these three forms of natural immunity. Horses possess a natural immunity common to the *species* against this disease. If the efforts to produce a race or breed of hogs immune to cholera results successfully they will have a *racial immunity*. An example of *individual immunity* is often seen in outbreaks of hog-cholera, in which a few hogs will pass through the infection without getting sick, although hundreds die. The individuals in these cases must be above the average of the species in immunity. It seems reasonable to attribute their protection to such factors as "strong constitution" or "good condition" rather than to specific bactericidal and other properties of their blood-serum.

Acquired immunity is the result of some influence acting after birth. This influence may be an attack of the disease, or the injection of preformed immune bodies (antisera). When acquired immunity is established through the activities of the individual's body-cells it is termed *active immunity*. Such protection is often permanent and lasts for life. An example of acquired active immunity follows the simultaneous treatment or vaccination of hogs to immunize them against cholera; the disease-producing substance (virus) is actually introduced into the animals to deliberately infect them. At the same time a protective immune antiserum is injected to assist the body in overcoming the effects of the disease. In case only the antiserum is injected into the hogs a *passive immunity* results, since a preformed immunizing substance is introduced instead of one produced by an active process on the part of the animals. Unlike the active type, passive immunity is temporary and of relatively short duration. Depending upon the disease which stimulates the body to produce immunizing substances, or the character of these substances, the immunity may be either antibacterial or antitoxic.

Susceptibility is the opposite of immunity, but, like immunity, is inherited, at least when particular to a species. The resistance of the animal is lowered, the normal equilibrium is disturbed, and virulent organisms, with the body defences off guard, take advantage of the opportunity to rapidly increase in number and

produce disease. It is not uncommon to find certain animals in a herd highly susceptible or predisposed to a specific disease while the rest of the herd shows great resistance. Experience goes to show that individual susceptibility is often due to "poor condition," temporary physical depression, fatigue, exposure to cold, poor hygiene, poisonous gases, etc.

Constitution is an important factor in determining the resistive influences possessed by the body against disease. A horse is said to have a "strong constitution" when his resistive powers are highly developed, and a "weak constitution" when he is susceptible to the influence of his surroundings. An individual may have much resistance against many types of disease influences and yet be weakly constituted in some way. The strength of general constitution is measured by the strength of the least resistive ability, like the strength of a chain is that of its weakest link.

Condition is that ideal state of the body which renders it fit for work. It is recognized principally by the rotundity and fulness of development. The term is frequently used by horsemen, and has come to signify the perfection of bodily health and vigor. An animal is said to be in the "pink of condition" when all the organs are working in harmony. The expression probably originated from the fact that the visible mucous membranes of healthy animals are always a delicate pink color. It is impossible to overemphasize the importance of condition in warding off disease. The common causes of putting an animal "out of condition" are similar to those mentioned as the causes of disease, only in a lesser degree. They include overfeeding, insufficient work, too much work, or too much work combined with insufficient food, and the result of lameness or sickness.

The facts detailed above explain why a given micro-organism may cause a fatal infectious disease in one animal but may produce only a moderate sickness, or cause no damage whatsoever, in another.

THE SYMPTOMS OF DISEASE

We have seen how disease modifies the body. It should not be supposed, however, that it is possible to distinguish closely between disease and health, or that one is just the opposite of the other. As a matter of fact, the two conditions blend almost insensibly. Only when an organ or group of organs is affected to

such an extent as to give visible signs of impairment is it possible to recognize the symptoms of disease.

A **symptom** may accordingly be defined as an external expression of any change in structure or function. Symptoms are varied in character.

Pathognomonic symptoms are those peculiar to a certain disease, and by which the disease may be positively recognized. **Non-pathognomonic symptoms** are those that do not indicate any definite or specific disease, but may be common to a number of diseases. They are, however, of great use, for their presence may show the absence of certain diseases with which the disease under consideration might be confounded. **Subjective symptoms** are those appreciated by the affected individual alone, as pain, impairment of vision, etc. **Objective symptoms** are those which may be discovered by the examiner, and include faults in the conformation, the gait, etc.

In veterinary practice it is impossible to determine definitely in all cases the exact period at which there is a departure from the normal state and commencement of disease. This is due to the fact that animals have not the power of speech to convey information to man concerning internal troubles, and because the alterations are so slight that they escape the examiner.

THE DIAGNOSIS OF DISEASE

Diagnosis is the art of determining the nature and location of disease. It is the first step in the attempt to restore health, and is invaluable in preventing the spread of communicable diseases. Since disease is a deviation from the normal, it is absolutely necessary to acquire a knowledge of the physiologic processes before one is able to recognize pathologic changes.

Experience in handling animals is the only way to learn how to diagnose their diseases accurately. Inability to determine the subjective feeling of the patient is not such a handicap as may be supposed, because the objective examination is always possible. We do not have notions, false modesty, vanity, or pride to deal with in animals.

Those changes which occur in the body as a result of external influences must not be confused with symptoms of disease. To illustrate, if a horse refuses feed it may be due to colic, excitement, or to poor feed. Therefore, we must consider in making a

diagnosis the work, food, care, exercise, etc., which the animal has had.

An examination of the patient to determine just what disease is present, and to what extent it has progressed, calls for the services of a well-trained veterinarian. Even an experienced diagnostician fails to make an absolutely accurate diagnosis in more than 50 per cent. of his cases. However, every horseman should be able to recognize the more common diseases. In order to do this correctly he should follow a systematic course in making the examination, using as aids things which will throw light upon the physical state and functions of the body organs.

In making a diagnosis the following physical aids, together with specially designed instruments of precision for the various senses, may be used.

Inspection, or the use of the eye, to record visible changes in the character of the respirations, the odor emitted by the secretions and excretions, the gait, and the posture.

Palpation, or the use of the sense of touch, to determine the size, shape, and consistency of the part.

Auscultation, or the application of the ear to the part, to detect unusual sounds produced as a result of disease and to learn the condition of the deep-lying organs.

Among the important points to be covered in the general examination to establish a diagnosis are:

(1) **Attitude of the Patient.**—Healthy horses stand or lie, but sick ones assume peculiar attitudes. For example, in pharyngitis or sore throat the head is poked out. Very sick horses hold the head down and droop the ears. The fore legs are held apart in chest troubles. Horses suffering from azoturia or tetanus are often unable to rise. In acute founder the patient stands with the hind legs well under the body and cannot be made to back.

(2) **Examination of the Skin.**—The skin's condition is an indication of the state of health. When the hair-coat is smooth and glossy it shows that the digestive organs are functioning properly and that the animal has been given good care. Alopecia, or falling of the hair from over the entire body, may follow recovery from severe diseases. The condition of the skin as to sweat secretion should be carefully noted. Profuse sweating occurs as a result of weakness, pain, and certain diseases of the muscles, like azoturia and tetanus.

(3) **Examination of the Visible Mucous Membranes.**—The conjunctiva or mucous membrane lining the eyelids and those at the natural body openings reveal the character of the circulating blood. Paleness indicates a congestion of blood in the intestines or a deficiency of the blood in general (anemia). Marked redness is present in all irritated conditions. If they are very dark red in color, there is a lack of oxygen in the blood (cyanosis). A yellowish discoloration occurs when the liver is deranged (jaundice).

(4) **Examination of the Pulse, Respirations, and Temperature.**—An examination of the pulse, respirations, and temperature will aid wonderfully in determining the state of health. None but a trained veterinarian can detect the minor variations from the normal. If the changes are marked, any person with a little practice should be able to recognize them. It should be remembered that they all vary normally within certain limits with the age and exercise of the animal.

The *pulse* varies in health from twenty-eight beats per minute for mature stallions to forty for high-spirited foals. It is taken at the margin of the jaw, where an artery winds around from the inner side. Other arteries are located at the inside of the elbow-joint and under the tail that are superficial enough for taking the pulse. As it is usually impossible to count the number of beats for a full minute, they should be taken for ten seconds at two or three different times, and the average multiplied by six to get the pulse-rate per minute. Variations as to frequency, rhythm, and quality may be noted. Stallions have a slower pulse than mares. The pulse is fast in severe diseases accompanied with fever, in all painful conditions, in excitement, and following severe hemorrhage. A hard pulse is always associated with a serious disorder.

The *respirations* may be counted by observing the rise and fall of the flanks, or in winter by watching the steam coming from the nostrils. Normally, the horse breathes from eight to sixteen times per minute. Rapid respirations due to recent exercise or excitement should not be confused with disease. A pathologic increase in the number of respirations is spoken of as dyspnea or labored breathing. Nearly every form of lung or chest trouble is accompanied with accelerated respirations.

The *temperature of the body* is measured by inserting a clinical thermometer in the rectum. Every person who has the care of stock should provide himself with one of these instruments, as it is

a most valuable guide for the early detection of disease. In the old days the temperature of an animal was determined by simply laying the hand upon the body of the patient. The ears, nose, and legs are the first parts of the body to show temperature variations. With the thermometer we have a much more accurate method of determination. A maximum-registering thermometer is used, and it must be carefully shaken down before insertion. It is not possible to give an exact figure for the temperature of the horse under normal conditions as it is for man, because many influences are at work. Experience shows that the limits are from 100° F. as a minimum to 102° F. for the maximum. Figure 46 is an illustration of a thermometer designed especially for the horse; the mercury stands at the average normal temperature. In the heat of the summer, after work in the sun, horses may show a temperature of 103.5° F. and be perfectly normal.

Fig. 46.—Clinical thermometer.

Three other aids in establishing a diagnosis are the making of diagnostic inoculations, a postmortem examination, and a biologic examination.

Diagnostic inoculations consist in the introduction of certain substances into the bodies of animals for the purpose of recognizing the disease or of obtaining an early diagnosis. They are only serviceable in those cases in which our examination leads us to suspect some infectious disease, such as glanders. In this particular disease mallein is injected under the skin or instilled into the eye of the patient, or an experimental animal is inoculated with nasal secretion, pus, etc., from the suspicious subject.

A **postmortem examination** is often required to establish a positive diagnosis, especially where one or two horses have died suddenly. In this work training and experience are called for to distinguish between changes due to disease and those caused by physical conditions. After death the blood gravitates to the lowest

parts of the body, and may be mistaken for an antemortem change in those organs in which it has accumulated. To be of value the postmortem should be held within a few hours after death, as decomposition changes set in rapidly, especially during warm weather.

Before moving a dead animal to a proper place for the postmortem examination the body should be inspected for external evidences of disease. The natural body openings should be examined for abnormal discharges which are significant of generalized infections, although bloating, decomposition changes, and similar conditions may be responsible for them. When summing up the results of the examination all external changes of an abnormal nature must be considered.

The chief changes to be looked for in the internal organs are the result of congestion of the blood. This is manifested by a red to purple discoloration.

In most infectious diseases the lymph-glands are the most valuable guide at the autopsy. They are located in connection with all important organs, and are the first structures to show evidence of trouble because they act as filters of the lymph which has bathed the tissue. Lymph-glands serve as active agents in limiting the spread of invading bacteria to other organs.

The cadaver should be rolled upon the back and propped up in that position. Then an incision is made through the skin and muscles of the abdominal wall from the sternum to the pelvis to bring the viscera to view. After careful inspection of the exposed organs for pathologic changes the carcass may be inclined to one side, and the stomach, intestines, spleen, bladder, and other soft organs removed for a more detailed examination. Care should be used to avoid puncturing the hollow organs, for their contents will escape and may seriously interfere with further work.

The incision made when the abdomen was opened should be carried forward to the throat. At this time it will be best to examine the nasal cavity, pharynx, esophagus, and trachea. In order to get at the organs in the thoracic cavity it will be necessary to divide the sternum or breast bone in its length. Especial note should be made of fluid found in this cavity. An excessive quantity indicates pleurisy. Adhesions of the lungs to the inner sides of the ribs are found as a result of inflammatory changes in the lungs. Healthy lung tissue is soft and spongy. If pneumonia is present, dark-red, firm areas will be found.

A biologic examination of the secretions, body fluids, and tissues may be needed to establish the actual cause of infectious and parasitic diseases. It is useful while the horse is sick as an aid to rational treatment, and very valuable after death in showing what measures are best to follow in protecting other animals from a similar infection. The microscope is the chief aid in this work. Within the last few years several different tests on the blood-serum have been used to advantage in this connection. Those of practical value are the complement-fixation, agglutination, and precipitation tests. The equipment needed to make the various biologic tests will be found only in up-to-date laboratories.

THE PREVENTION AND CONTROL OF DISEASE

In recent years in veterinary medicine, as well as general medicine, more attention has been given to the prevention and control of disease than to its treatment. This is one result of the better knowledge of disease processes which has been afforded by the valuable contributions to the study of bacteriology and pathology. We have come to realize that it is much more economical to keep our animals free from disease than to wait until they get sick and then spend both time and money in restoring them to health. The science of preventing the occurrence of disease in and the extension of disease to healthy animals is termed "prophylaxis."

Prophylaxis consists in attention to hygiene, the proper selection of animals for breeding, the elimination of agents by which infection is spread, and in disinfection and quarantine measures for controlling disease.

Hygiene is the science and art of conserving and promoting the health. It has for its purpose the regulation of the diet to retain and strengthen the animal organism by increasing its natural resistance. By following its tenets the greatest degree of bodily health may be secured and premature death prevented. In a broad sense, it includes not only attention to all those things mentioned in the definition of prophylaxis, but also most of those that are discussed under the section devoted to the treatment of disease.

The **selection of animals for breeding** is an important factor in the prevention of disease very frequently overlooked. Carelessness in attending to this detail of horse husbandry leads to lowered

vitality of the stock. Breeding from immature or diseased animals is the main cause of inherited weaknesses. The evil effects are seen in the offspring of inbred parents and those of too young or pampered mares. The foals may be of normal size, but lack vitality, and are born dead or die during the first few weeks of life. By breeding only from sound, mature stock diseases and weaknesses of this nature can be avoided.

The **elimination of agents which spread infection** is necessary if diseases are to be effectively controlled. Here consideration should be given to dogs, birds, and all animals coming from infected places, whether they themselves are sick or apparently healthy; hay and grain from quarantined areas; water from public drinking troughs and other contaminated sources; stock cars, pens, and shows.

Disinfection is the process of destroying disease germs by means of heat, cold, chemical substances, or fumigation. It is the chief weapon of the sanitarian in preventing and controlling infectious diseases. Disinfection differs from antisepsis in that it has for its object the absolute destruction of micro-organisms instead of simply preventing their growth and development.

The ideal disinfectant is one which will destroy the germs without injury to the object. There is no one agent or method applicable in all cases, therefore the conditions must be studied in each case and the most suitable disinfectant selected. In any event, the disinfectant must come in actual contact with the material which is to be disinfected for effective results.

Heat in the form of fire is the most valuable and reliable disinfectant. A discussion of its action would be absurd, for all understand the manner in which it works. Cold is less effective than heat as a disinfectant. In the northern states, where the winters are long and rigorous, most disease-producing micro-organisms are unable to survive unless protected in manure piles and other places secluded from frosts. In some outbreaks of infectious diseases it has been observed that there is a tendency for them to "die out" in the winter. The action of cold is often accountable for this desirable turn, but too much reliance should not be placed in it, besides the chances of introducing a fresh infection are numerous.

Chemical disinfectants are most commonly used about the farm because they are easiest to apply. It is impossible to state which

is best, for the nature of the substance to be acted upon must be considered. Bichlorid of mercury, commonly called corrosive sublimate, is in favor with many. It has the power to destroy all forms of microbes in relatively weak solutions. It is a cheap, reliable, and easily handled disinfectant, but has the disadvantage of being very corrosive and extremely poisonous. Carbolic acid is commonly employed. It does not injure clothing, metals, or wood, and does not coagulate albumen so readily as bichlorid of mercury. On the other hand, carbolic acid is not so trustworthy as some of the other disinfectants on the market. Coal-tar dips, under various trade names, are useful, but the phenol coefficient of each should be obtained from a trustworthy source before reliance can be placed in them, as their disinfectant properties vary within wide limits.

Fumigation is in most cases impracticable for stable disinfection. This is due to the impossibility of making the stable airtight. When this can be done, various poisonous gases like formaldehyd or carbon disulphid may be used to advantage.

Quarantine is a safeguard against the spreading of disease. It is always advisable to place in quarantine recently purchased animals or those returned to the farm after a prolonged absence. In this way only can diseases be prevented from getting a foothold. Separate attendants should be employed for quarantined animals, or a change of clothing, more especially shoes and overalls, provided for the men.

THE TREATMENT OF DISEASE

The term **therapeutics** is used to cover all the curative forces employed in the treatment of disease. Treatment consists in removing the cause of disease and the support of nature in her endeavor to combat the malady.

This suggests the first questions to be considered in outlining a course of treatment; namely, can the disease be left to nature's care, or is medicinal treatment needed or desirable? If we decide to lend aid, the question immediately arises about when to help and when to hinder nature's curative processes. How to help without doing harm is a problem of prime importance, the solution of which calls for mature judgment.

In general, it may be said that treatment must be instituted early in the course of a disease—that is, before the pathologic

changes have become marked and the natural processes inhibited—if the best results are to be expected from it.

A careful study of the causes of disease and the symptoms exhibited by the patient, as previously explained, should give the stockman a basis upon which to work, and indicate to him the best method to pursue to remove the exact cause of trouble, without which only imperfect results from any line of treatment should be anticipated.

Nature may be supported in overcoming disease by those things which are available in almost every stable. It is not so much what is used as how it is used. First-aid treatment should not call for expensive and rare equipment, but the intelligent use of the means at hand.

The same principles for the treatment of disease apply in veterinary practice that are employed in human medicine. The remedies which may be used are various and numerous. The term "remedy" is used here in a comprehensive manner, and does not signify the same thing as medicine or drug, but includes all therapeutic aids used for the cure of disease and to promote restoration to health. In general, these are proper nursing, stable quarters, clothing, food, water, rest, exercise, and the use of different medicines. Operative treatments are also to be considered as therapeutic remedies.

Nursing is just as essential in the treatment of a sick horse as for a sick person. When rendered in a sensible manner it hastens recovery and fits the animal more promptly for return to service. Veterinarians of wide experience place more value in a good nurse than in medicine. A competent nurse not only cares for the animal, but is also observant enough to anticipate changes for the better or worse in the patient, and provides comforts before they are absolutely necessary. In such diseases as colic, when the horse is in the throes of acute pain and rolls or throws himself, a nurse should be in constant attendance to prevent the animal from serious injury. Among the duties of the nurse is that of grooming. When this is done in a proper manner benefits are certain to accrue. It keeps the skin clean and more active in disposing of waste products. When combined with vigorous rubbing it imparts to the muscles all the benefits of massage.

Stable quarters suitable for the particular patient should be provided. A large, airy box stall, which has been freshly cleaned and whitewashed, ought to be available for emergency cases.

Good light, freedom from drafts, and bedding of a loose texture, such as straw, sawdust, or shavings, are all important details to be looked after when preparing a place for the sick animal. Patients suffering from a nervous disease, like tetanus, need quiet, so an effort should be made to avoid noises and other annoyances. Darkening the windows of the stall will be found helpful in caring for nervous animals, and in summer has the additional advantage of keeping out flies. A temperature of 45° to 50° F. is best for most housed animals in the winter.

Horse clothing consists of blankets, hoods, and bandages of various kinds. Blankets are necessary in the winter to protect the horse from exposure to the elements. In the summer light cotton sheets are useful in affording protection from the attacks of flies and other biting insects. A specially designed hood is useful in throat and lung diseases to protect the head and neck. Too much covering is detrimental to health and should be avoided, for the skin will be hindered in performing its functions of an excretory and temperature equalizing organ. Damp, foul-smelling horse clothing is harmful, so care must be taken to air and dry it each day. Bandages protect, warm, and support the legs. Those made of flannel are preferable. The woven cotton, or Derby bandages, possess much elasticity and are very serviceable. Bandages should be changed several times daily, and at each change a thorough hand-rubbing given the legs to stimulate the circulation of the blood. At the same time the application of a mild, stimulating liniment, composed of equal parts of alcohol and witch hazel, may be made. Strong liniments applied under a bandage will blister. When applied to the legs bandages should be rolled from below upward to prevent interference with the flow of blood in the veins. Care should be taken that no wrinkles are left to cause unequal pressure and interfere with the circulation. If a bandage is too tight a ring-like swelling appears above and below it.

Food for sick horses should be selected very carefully. Confined animals are usually fed too much. Digestive disturbances can be materially alleviated by withholding feed for ten or twelve hours. Smith says that, instead of forcing food on a horse which is "off his feed" from overwork and giving him stimulants, it is much better to allow him a full supply of drinking-water and some green food or carrots, so as to facilitate the removal from his system of the deleterious products that are the cause of his depression.

When they have been excreted, his system will demand materials for repair, with the result of healthy general stimulation. On the other hand, animals suffering from debilitating diseases should be tempted with appetizing food of an easily digested and nutritious nature, as good food plays an important part in the treatment of sick animals, building up the weakened and wasted tissues. Food should be given only in small quantities, as the animal will usually have a poor appetite, and any portion left over soon becomes tainted with stable odors, which render it unpalatable. When such food is left before the patient for any length of time it will have a tendency to take away all appetite. The best way to increase the appetite of a horse is to change the character of his feed frequently. Food that is wet, such as bran mashes or steamed oats, will soon sour in warm weather, or will get cold in the winter. Colic and diarrhea often result when food of this character is eaten. Feed which has been slobbered on undergoes fermentation very rapidly, due to the action of the saliva upon the food constituents. Food should not be forced upon a horse, for we should remember that the state of his appetite is the best guide by which we may know whether his system requires food. Common salt, according to Kellner, exerts a physiologic action in digestion by serving as a spice or condiment which stimulates the appetite and increases the palatability of the food. It also stimulates the secretion of the digestive juices, increases and hastens their action, and prevents digestive disturbances. As a complement to the food it is of prime importance.

Water should be kept constantly within reach of a sick horse. It should be pure and fresh. The animal will often rinse out his mouth, and if suffering from a feverish condition will find much relief even if not thirsty. When allowed to stand about for any length of time water becomes flat. Drinking-water should be curtailed if diarrhea is present. The custom of taking the chill off water is beneficial. Ice-cold water is bad for all animals. Water as a diluent of the digestive fluids permits them to come in contact with and thus act more efficiently on foods; the softening materially assists in the processes of mastication, digestion, absorption, and assimilation. Furthermore, it is useful in eliminating nitrogenous waste from the body through the urine. Medicines should not be given in the water unless they are tasteless. As a rule, it is safe to allow horses all the water they desire to drink.

Rest is essential for a rapid recovery. It is nature's specific for all diseases. Rest must be insisted upon as an adjunct to other lines of treatment. It includes the removal of the saddle if saddle-gall is present, withdrawal of nail in nail prick, change of ration or withholding of the same in indigestion. Young horses and those recovering from disease need more rest than other animals. Colts are easily stunted by putting them to work too early. Dr. Gulick has said that growth is predominantly a function of rest. Work is chiefly an energy-expending and tearing-down process. Work may furnish the conditions under which subsequent growth may occur, but in itself it is destructive. By work we do things in the world, but we do not grow by work; we grow during rest. It is not the only condition of growth, but it is one of the essential conditions.

Exercise is as important in the treatment of disease as rest. It should be given daily, but in moderation, unless the patient is suffering from a disease accompanied with a high fever, or is undergoing treatment involving immobility of a certain part, when better results will be had from absolute rest.

Medicines are agents of animal, vegetable, or mineral origin used for the cure of disease or the relief of pain. The study of the derivation, physical and chemical properties, physiologic actions, and doses of drugs is known as materia medica. For full information on this subject reference must be made to appropriate textbooks. Attention is drawn in this connection to the rapidly increasing use of serums, vaccines, and other new biologic products in veterinary medicine. Their field of usefulness is great when they are employed in an intelligent manner. When used early as preventive agents they are especially valuable; many also have given success as curative agents.

Operative treatment means the use of surgery or surgical methods as therapeutic aids. For the removal of tumors and foreign bodies, and in the treatment of many of the common diseases of the horse, this method of treatment is required in order to secure a cure.

THE TERMINATION OF DISEASE

Disease may terminate in:

(1) **Recovery,** by which the body regains its normal condition, its functions being re-established by the various regulative mech-

anisms, and harmful agencies neutralized, poisonous substances eliminated, and the tissues repaired.

(2) **Incomplete recovery,** where, after a disease has run its course, there is some permanent impairment of tissue (sequelæ of disease); for example, adhesion of the lungs after pleurisy, opacity of the previously transparent parts of the eye, deformities of bones. Many times the organ will be, for all practical intents and purposes, as serviceable as before.

(3) **Death,** which occurs when the vital organs suspend their functions. It is brought about by the failure of either the respiratory, the circulatory, or the nervous functions, or it may be due to a complication of these causes. Death may occur suddenly, in which case the animal collapses, becomes unconscious, and for a few moments at most is thrown into convulsions, as in lightning-stroke or sunstroke. In the majority of cases death comes on gradually, and terminates in the so-called death agony or death struggle. This mode shows progressive paralysis of the different systems of body organs. Animals in the agonal state are unable to rise, lie flat on one side, and lift the head from time to time and let it fall heavily. They may sweat profusely and involuntarily void urine and feces.

CHAPTER XI

GENERAL PATHOLOGIC CHANGES

THE BLOOD IN DISEASE

General disturbances of the health are accompanied by changes in either the distribution or the character of the blood, or both. When the various functions of this highly important fluid are recalled, it is readily understood that any alteration in it endangers both life and health.

Normally, both the quantity and quality of the blood are maintained at a point just high enough to meet the requirements of the body. When the demands for blood are great in one set of organs as a result of increased activity, there is a corresponding decreased demand in other parts. An organ rich in blood is said to be congested or hyperemic, while one poor in blood is anemic. In moderation, either condition may be physiologic. Only when these changes have progressed to such an extent that the physiologic activities are interfered with is a pathologic condition said to exist.

Congestion, which may be either active or passive, is an increase in the quantity of blood in a part. It may be due to an excessive inflow of blood or to a diminished outflow.

Active congestion is that condition in which the arteries are overfilled with blood. It is caused by agencies which produce an increased flow of blood in the part, such as mechanical and chemical irritants. The part appears slightly larger, redder, and warmer than normal. These changes are due to the fact that the blood is prevented from circulating as it should; for example, congestion of the udder. Long-continued congestion leads to permanent enlargement of the part. Fortunately, it is usually only temporary, so permanent injury rarely results unless complications take place. Active congestion is seen in inflammation, where it is always a symptom.

Passive congestion is an overfilling of the veins with blood. The affected part becomes larger and bluish red in color. In most

animals the color cannot be seen, as the skin is pigmented. The "stocking" or filling of the legs is a form of passive congestion. It may be prevented by hand-rubbing and applying bandages to the legs as soon as the horse returns from work. A laxative diet should be provided for such animals. The swelling which occurs along the belly of a mare a few days or weeks before foaling is another example. It is either due to a compression of the walls of the veins, so that blood cannot circulate freely through them, or to weakened heart action. In certain cases the watery constituents of the blood may exude from the skin. The large milk veins of some cows are often in a state of passive congestion due to a damming back of the blood into them. In such cases they are not an index to the quantity of milk which the animal is capable of producing.

Anemia is the opposite of congestion. In this condition there is either a diminution in the quantity or quality of the blood. It may be either general or local.

General anemia is due to a deficiency in the total quantity of the blood. It is caused by excessive hemorrhage, poor nutrition, or anything which destroys the red blood-corpuscles, particularly parasites. Animals suffering from general anemia are said to have "thin blood," their mucous membranes are pallid, and they are listless.

Local anemia is that condition in which there is less blood in the part than normally, but the total amount of blood in the body is not reduced. It is brought about by (1) pressure on the part; (2) a thickening in the wall of a blood-vessel; (3) partial occlusion of the artery to the part; (4) cold and chemical agents; (5) congestion of blood elsewhere in the body. The part affected feels cooler and is paler than normal. If long continued, death of the part takes place from lack of blood supply.

Dropsy is a pathologic condition closely associated with alterations in the blood. It may be defined as an abnormal collection of a watery, straw-colored fluid in any body cavity or tissue. The horse is less commonly afflicted than sheep and other animals. Two common forms of dropsy are ascites and hydrothorax.

Ascites is an accumulation of dropsical fluid in the abdominal cavity. It is caused by anything that interferes with free circulation of the blood, so that the blood is dammed back into the veins. A poor diet and blood parasites, which alter the char-

acter of blood or destroy the corpuscles, may be responsible for ascites. The chief symptoms are distention of the belly and marked swelling of the limbs. Treatment consists in abundant nutritious food, iron tonics, and drugs to act on the kidneys to induce the urine to flow more freely. Tapping the animal to permit the fluid to escape is often necessary, but affords only temporary relief.

Hydrothorax is a complication of certain forms of pleurisy. It is characterized by an accumulation of fluid in the thoracic cavity, When present this form of dropsy may be diagnosed by tapping the lower part of the chest wall. If the ear is placed over the chest a sound resembling that of drops of water falling into a well may be heard.

INFLAMMATION

Inflammation is the one constant factor in all pathologic changes. By its aid the body overcomes disease, heals wounds, and unites fractured bones. It has been defined as the highly complex reactive process which living tissues show to an irritant.

The term "irritant" may be best understood by first learning what is meant by a stimulant. A stimulant is anything that produces action in a living tissue, like the application of a mild liniment to the skin. When excessive stimulation is applied, like a very strong liniment or blister, irritation results. Irritants and stimulants, therefore, differ only in the degree of action which they produce in the tissues.

The *changes in inflamed tissues* consist of a series of processes entirely similar to physiologic procedures, only in more marked manifestation. Besides an increase in the nutritive substances brought to the part, there is mobilized a whole army of leukocytes to attack the irritant agent and neutralize its poisons.

The **causes of inflammation** include a great variety of mechanical, thermic, chemical, electric, and infectious agents. Examples of each are seen on all sides. The first four of these causes may be classed as non-bacterical in character, and produce an *aseptic* or *non-infectious inflammation*. The infectious agents consist of micro-organisms which set up a *septic* or *infectious inflammation*. Depending upon the virulence of the invading bacteria, there results either a rapid general infectious process with fatal termination or, where the micro-organism is of lower virulence, a slowly

developing inflammation, which may be overcome by the bactericidal substances of the body before much damage is done.

The **kinds of inflammation** depend upon the character of the exudate produced. The simplest kind is a *serous inflammation,* in which a watery exudate like the contents of a water-blister is formed. A *suppurative inflammation* is accompanied by the formation of pus; a good example is an abscess. A *productive* or *proliferative inflammation* is the kind most common in bone tissue, like ringbone and spavin growths. *Croupous* and *diphtheric inflammations* occur on mucous membranes.

The **course of inflammation** is determined by the rapidity and intensity of the process in the inflamed tissue, and may be either acute, subacute, or chronic.

The **symptoms of inflammation** are heat, redness, swelling, and pain. *Heat* is mostly due to an increase in the amount of blood flowing through the part. *Redness* is observable only in white-skinned animals, and is due to more blood than normal in the part; however, inflamed mucous surfaces in all animals readily show it. *Swelling* is the result of the same cause plus the inflammatory exudate or fluid which oozes out of the blood-vessels to bathe the tissues. *Pain* results from undue pressure on the sensitive nerves.

The **treatment of inflammation** should be directed toward assisting the body in its endeavors in removing the irritant cause. In case the inflammation is of an aseptic nature, treatment will be largely symptomatic. When sepsis is present the mode of procedure must be varied to suit the particular case. Local remedies for the treatment of inflammation are rest, heat, cold, massage, counterirritants, and antiseptics.

Rest is most important, for it involves removal of the irritant. It also supports the action of other remedies.

Heat is indicated only in cases where no bacterial infection is present. It stimulates the circulation, and thus promotes the absorption of the exudate and hastens the elimination of the waste products. Under the influence of heat the tissues relax, so that pressure is taken off the sensitive nerves and pain is relieved.

Cold is useful in the first stages of acute inflammation and in septic conditions. It contracts the tissues and lessens the vitality of the part. No fixed rules can be laid down for its application. In practice cold is used in the form of cold water or ice-packs.

Massage is an important adjunct to healing in non-infectious inflammations, but is contra-indicated in septic conditions, as it tends to relax the tissues and thus allow resorption of toxic products.

Counterirritants are used for deep-seated inflammations. They stimulate blood circulation and are very important aids in veterinary medicine. They are applied as blisters, or the actual cautery in the form of the firing iron, to hasten the process by transforming a chronic into an acute inflammation.

Antiseptics are valuable in treating septic inflammation. For this purpose camphor, carbolic acid, and iodin are especially recommended.

The **termination of inflammation** depends upon the amount of injury to the tissues. When the irritant is removed and the inflammatory product is entirely absorbed, resolution follows and the part fully regains its normal functions. The production of new growths, adhesions between organs, and the retention of an exudate in a cavity are other forms in which inflammation may terminate, but they always interfere more or less with the functional activities. In severe disturbances of the circulation gangrene or death of the tissues occurs.[1]

FEVER

Fever, like inflammation, is to be regarded as a natural reaction of the body designed for protection. It is a symptom of disease rather than a specific affection. All infectious diseases are ushered in with a rise in the body temperature, which makes this symptom the most reliable guide for the diagnosis of diseases due to microbic invasion.

The **cause of fever** is not definitely known. However, any disturbance in the thermal center at the base of the brain may result in elevation of the body temperature. In health this center harmonizes the forces for heat production, heat dissipation, and heat regulation. When the products of bacteria or the organisms themselves gain entrance to the fluids of the body, they irritate the thermal center and lead to its deadening. Examples of infectious fevers are those caused by the micro-organisms of strangles and glanders. In other cases fever occurs without the intervention of bacteria from the resorption of products resulting from the disin-

[1] The student should compare this section with that on the Termination of Disease.

tegration of blood, painful conditions, rheumatism, fatigue due to fighting against restraint, overheating, etc.

The **kinds of fever** are determined by the height of the temperature. We speak of a mild fever, 101.5° to 103° F.; a moderate fever, 103° to 105° F.; a high fever, 105° to 106.5° F.; and a very high fever when the recording thermometer registers 106.5° F. or higher.

The **symptoms of fever** include a rise in the temperature, changes in the secretions and excretions, a rapid pulse, accelerated respirations, dilated nostrils, a hot dry skin, increased thirst, loss of appetite, and digestive disturbances. Sometimes chills are evident at the onset of fever, causing the patient to tremble and shiver throughout the body. Chills are accompanied by erection of the hair coat and a cold skin. These changes are due to a congestion of the blood in the internal organs which leaves the surface of the body cold.

The **crisis of fever** is the turning-point when the temperature falls abruptly. Often the crisis is accompanied by critical discharges, such as critical profuse excretion of urine, critical diarrhea, or critical sweat. A day or two preceding the crisis the temperature drops almost to normal, but immediately goes up again. This is the pseudo or false crisis. Before crisis occurs the temperature is higher than at any other time during the disease. This is the period of critical change. Animals often die when the temperature has reached its lowest point. The decline of fever preceding recovery is believed to be due to the formation somewhere in the body (bone-marrow, liver, or spleen), during the febrile process, of a large quantity of protective substances (antibodies), and to the destruction of the fever-producing substances present in the system from the time when the protective substances predominate.

The **prognosis in fever** should be guarded, for we find that recovery from diseases accompanied with high fever is quite slow, because the body must replace the large amounts of tissues destroyed by the extreme oxidation. The age, vitality, and care given the patient will be important factors in determining the outcome.

In the **treatment of fever** only those therapeutic agents should be used which tend to keep it within bounds and prevent structural changes in the internal organs, for we know that beneficial effects follow ordinary degrees of fever from the fact that the higher tem-

perature tends to retard the growth of many pathogenic organisms. Furthermore, in proper limits it is stimulative to a worn-out and wasted economy.

Six ounces of Glauber's salts or other gentle laxative will be found beneficial in the first stages of fever. This simple remedy helps to reduce the temperature by emptying the intestinal canal, and by hastening the elimination of infectious materials through stimulating the intestinal gland secretions. Drastic purges should be avoided, as they are likely to set up a diarrhea which may be impossible to control. Various agents, known as antipyretics, are used to reduce the body temperature. They act either by preventing oxidation or stimulating the radiation of heat. Among the commonly used antipyretics are aconite and acetanilid, but they are dangerous in the hands of the inexperienced man. The antiseptic treatment of fever is discussed in the section on Wound Fever.

HYPERTROPHY

By the term **hypertrophy** is meant the enlargement of a part of the body. The increased size may be due to either physiologic or pathologic causes. In either case the part or organ involved takes on increased functional activity. An example is seen in the case of a giant, where the condition is general. Physiologic hypertrophy occurs because an increased demand is made upon the organ; for example, the muscles of a gymnast or the biceps of the blacksmith. The heart shows the effects, especially in horses used for fast or very heavy work. In these the heart is always much larger than in animals not placed under such strain. Comparison of the heart from a dog with one from a sheep or pig of the same weight will reveal a decided difference, due to their mode of life. If one kidney becomes diseased and cannot function, the opposite is increased to double the usual size (compensatory hypertrophy); but there is usually no indication of kidney disease observable during life.

ATROPHY

Atrophy, the reverse of hypertrophy, is a wasting away or diminution in the bulk of one or more of the component parts of an organ, accompanied by a diminution in function. Examples of atrophy are seen in the thymus gland of young animals, the uterus of old mares, and "sweeny" following injury to the shoulder muscles. A peculiar form of this change is called "senile atrophy,"

noticeable in the sexual glands of the aged and prematurely aged. Brittleness of bones in the old is another example. Causes of atrophy include all those factors which interfere with the nutrition and activity of an organ. In starvation the fat of the body disappears and the organs atrophy, so that the animal may lose more than half in weight. Deficient nutrition, due to interference with the normal blood supply, may occasion atrophy. This form is seen when the chief artery to a part is ligated. Constant pressure inhibits growth and leads to a decrease in size, as may be seen in the deep groove left across the nose of a horse tied for a long time by a halter with a tight nose-band. In old horses the liver is smaller than in young animals, due to long-continued pressure from other abdominal organs. Continued lack of use causes an "atrophy of inactivity." It is observed in the muscles after prolonged fixation of a limb in splints.

CALCULI AND CONCRETIONS

Calculi are formed by the precipitation of salts which have become insoluble. They may be found in the intestines, kidney, or bladder. *Intestinal calculi* appear as rounded, stone-like bodies. They usually weigh from 2 to 3 pounds, although one horse is reported to have had a calculus weighing 16 pounds. *Renal calculi* usually occur as soft, mortar-like masses in the pelvis of the kidney, where they may be present for a long period without causing a visible disturbance. *Cystic calculi* form in the bladder from nuclei the size of grains of sand. They may grow by accretion until they are as large as a baseball. Some are quite smooth externally, others are very rough and continually irritate the bladder, causing the horse to urinate at frequent intervals. Solvents for cystic calculi are not very successful. Operative treatment by which they are completely removed is the only satisfactory method to handle these cases.

Concretions are formed of closely packed undigested vegetable matter and are found only in the digestive canal. The hair-like processes on the stems and heads of crimson clover which has been allowed fully to mature before cutting may form "hair balls" when eaten by horses and mules. To avoid this trouble such hay should be fed in small quantities or mixed with other hay. If it is sprinkled with water twelve hours before feeding the claim is made that the danger of hair-ball formation is considerably reduced.

CHAPTER XII

WOUNDS AND WOUND INFECTIONS

THE SYMPTOMS, TREATMENT, AND HEALING OF WOUNDS

A *wound* is any break in the continuity of the skin or mucous membrane. More or less destruction of tissue always occurs as the result of a wound.

The following kinds of wounds are recognized: (1) *Incised wounds*, with clean-cut margins; (2) *lacerated wounds*, with flap-like tears; (3) *punctured wounds*, with small, round openings; (4) *contused wounds*, with the tissues bruised from contact with a blunt instrument. The size of a wound is no guide to the prognosis, which should depend in large measure on the situation or the wound and the nature of the injured vessels. Minor wounds are just as likely to lead to complications as are extensive ones.

The **symptoms of wounds** are hemorrhage, pain, gaping, and disturbed function.

Hemorrhage is the escape of blood from the tissues in which it is normally contained. It varies according to the size and kind of the wounded blood-vessel, but is most pronounced in incised wounds. When an artery is injured the blood is bright red in color and spurts out with each heart-beat. An injured vein allows blood of dark-red color to escape—it flows steadily from the wound and upon exposure to the air turns lighter red. Capillary hemorrhage is intermediate in color and oozes. If hemorrhage is into the body cavities, the blood is rapidly and entirely absorbed. From the tissues absorption is slower, and a "black-and-blue spot" or "blood blister" (hematoma) remains for some time to mark the location. Where over one-third of the total volume of blood is lost, the pressure falls and death may follow. After excessive loss of blood the visible mucous membranes become very pale, the animal gets dizzy, loses consciousness, and goes into convulsions. There is a rapid re-establishment in the quantity of the blood following hemorrhage by absorption of fluids from the tissues and intestines. The solid constituents regain their normal numbers more slowly,

for they must be manufactured by the various blood-forming organs.

Pain results from injury to the sensitive nerves. The blunter the cutting instrument and the slower the separation of the tissues, the greater is the pain. There is much variation in the ability of different horses to bear pain.

Gaping refers to the separation of the margins of the wound. A transverse wound always shows this symptom more than a wound in the same direction with the fibers of the injured tissues. Gaping is most pronounced in incised wounds.

Disturbed function is evidenced by such symptoms as lameness, impaired mastication, or inability to swallow.

In the **treatment of wounds** the first thought should be the arrest of hemorrhage, then the removal of foreign bodies, and finally the dressing of the wound.

Arrest of hemorrhage normally is brought about by the contraction and retraction of the ends of the severed vessel's walls and the formation of a blood-clot. When these natural processes are not sufficient, artificial means to control the loss of blood must be employed. These consist of the following:

Ligation or tying the bleeding vessel. For this purpose silk or catgut is used. Artery forceps are useful to pick up the injured vessel so that the ligature may be applied.

Compression by the application of a hard pad or bandage. Even pressure with the finger over a cut vessel gives temporary relief. An elastic bandage, towel, or other form of tourniquet tied on the side nearest the heart is a temporary method of restraining bleeding.

Torsion or twisting of the vessel on its long axis retards the flow of blood so that a clot forms.

Heat, in the form of a red-hot iron, is useful where smaller vessels are wounded. It also assists in destroying infectious material which may have gained entrance to the wound, and leads to the formation of a scab to seal the wound against subsequent infection.

Chemical agents, like iron chlorid and oil of turpentine, have been used with more or less success, but are only serviceable when the hemorrhage is slight.

Removal of foreign bodies should be the second step in wound treatment. Pieces of wood, wire, glass, slivers of bone, and clots

of blood may be found in wounds. Unless all foreign and dead matter is removed it will be impossible to get permanent healing.

Dressing wounds is an art. Under this head are included the cleansing, suturing, and bandaging of wounds. A 3 per cent. solution of carbolic acid in soft water is a reliable cleansing agent and possesses antiseptic properties. It may be applied with a small syringe or by moistening pledgets of absorbent cotton.

By suturing is meant the sewing together of the wound edges. It is necessary where there is much gaping. For this purpose heavy silk is used when it is available. In an emergency heavy linen thread, or common white twine and a darning needle, may be used. Whatever material is employed must be boiled or soaked in a strong disinfectant solution to render it sterile. The stitches are to be taken a considerable distance from the margins of the wound in order to prevent tearing. Do not draw the stitches too tightly

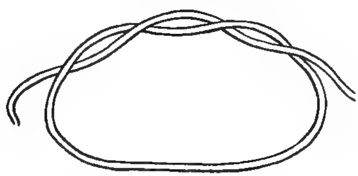

Fig. 47.—The surgeon's knot.

or the swelling, which always follows, will cause them to tear out. The surgeon's knot (Fig. 47) is employed to tie the ends together. Stitching is contra-indicated where much pus is apt to form.

Bandages to protect against infection and injury are helpful in operation wounds and wounds near the feet where filth is apt to enter. Many wounds, especially barbed-wire cuts, heal better without bandaging. Bandages and other dressings must be changed as soon as they become saturated with the wound secretions. At this time the wound is cleansed with an antiseptic solution. The surface of the wound should be sopped instead of rubbed, to avoid irritation and injury to the newly formed granulation tissue. A dusting-powder, composed of iodoform or boric acid, or equal parts of iodoform, boric acid, and tannic acid, may be sifted on to the wound to check secretions and promote healing. If pus has a tendency to collect in pockets, these should be swabbed out daily or opened so as to allow free drainage.

Attention is called in this connection to the use of hydrogen peroxid as a surgical antiseptic, for the reason that it is much less valuable than is popularly believed. In the presence of organic matter it rapidly reduces and loses its disinfectant property. It is a powerful deodorant, but should not be relied upon as an antiseptic. Compared with carbolic acid it is about $\frac{1}{60000}$ as efficient. When applied to a wound with much pus accumulation it acts mainly as a mechanical agent to bring the tissue débris from the depths.

Wound healing is the process by which the destroyed tissue is replaced and the normal condition is restored. The rapidity and completeness of recovery is determined by the form of wound healing which takes place. The three following forms are easily recognized:

(1) *Healing by primary intention* consists of a direct and rapid union of the margins of the wound without the formation of pus. In order that a wound may heal in this manner it must be fresh and non-infected, have even edges, and have lost but little substance. Minor cuts and other wounds of man heal by this method if kept free from organismal contamination. In our domestic animals these conditions are found only in operation wounds, and then only when protection is afforded by bandages. Within twenty-four hours the edges of the wound adhere with blood, afterward a fluid-like substance, wound cement, performs this function. The surface of the wound remains dry. In four to eight days definite union results, and a small scar is the only sign left of the injury.

(2) *Healing by secondary intention* is characterized by the production of granulation tissue, and is generally accompanied by pus formation as a result of infection from pus-producing organisms. Old wounds, infected wounds, and wounds with loss of substance heal under this method. The granulation compensates for the destroyed tissue, and also forms an important protection against the entrance of any infectious material into the blood-stream where it might be spread to all parts of the body. It is a good sign to see granulations appear in a wound, for there is then no further danger from absorption of poisons. This function of granulation tissue has been demonstrated by placing pure cultures of anthrax bacilli on a granulating wound of a sheep. The disease did not develop, even though sheep are very susceptible to anthrax.

(3) *Abnormal wound healing* implies the formation of excessive amounts of granulation tissue, termed "proud flesh" or "grapes," a complication often seen in wounds around the hoof-head. It occurs when the process of healing is too rapid. The cause is excessive irritation from mechanical irritants, like licking and rubbing the part; or chemical antiseptics, like copper sulphate injudiciously used; or bacteria in great numbers. Proud-flesh formation must be stopped before the wound will heal properly.

A **scar** is the result of the newly formed connective-tissue cells, which contract and force the blood out of the part, leaving the typical white condition. A scar contracts for a long time after healing has taken place. This accounts for the pulling and "stitches" felt in healing and healed wounds. If the end of a severed nerve becomes caught in the scar-tissue when the wound heals, pain may be felt for years, but is always referable to the normal ending of the nerve.

Old wounds may need to have the edges freshened, especially if they are to be brought together by sutures, so that the skin cells may proliferate and healing take place more readily. Healing can be stimulated in old sores by applying a blister.

SPECIAL KINDS OF WOUNDS

Galled shoulders result from improperly fitted collars, too large collars, collars too wide at the top, or an accumulation of dried sweat and dirt on the collar or collar pad. The first step in remedying this trouble is the adjustment of the collar to the neck by fitting it snugly. If this is not successful in preventing further galling, the draft should be raised from the point of the shoulder. Treatment for galls does not differ from that outlined for other wounds. Washing the shoulders night and morning with a solution of common salt and water in the proportion of a dessertspoonful to 1 quart is useful to keep the skin clean and toughen it. Sometimes a hole cut in the sweat pad, at the place where it comes in contact with the wound, will give relief and hasten healing. Obstinate cases are often due to deep-seated abscesses and require an operation for a permanent cure.

Sore neck is caused by excessive collar pressure and rubbing. First see that the draft is not too high up, for this has a tendency to pull the collar downward and bring too much pressure on the top of the neck. Try slackening the hame strap at the top and tight-

ening the one at the bottom. Treat as advised for galled shoulders. Sometimes a depression or "pocket" appears in the center of the raw surface on top of the neck; as a result, an accumulation of the wound secretions occurs. Later necrosis may set in. If it does, a "sit fast" develops which can only be satisfactorily treated by having the dead tissue removed with a surgeon's knife.

Cracked heels, scratches, or **mud fever** are terms applied to inflammatory changes in the skin which result in transverse cracks across the hollow of the heel. The condition may be acute or chronic. It is oftenest seen in the winter and spring, when the feet are apt to be wet much of the time. Other causes are washing the lower limbs but failing to dry them thoroughly; overfeeding with concentrates; lack of exercise; leaving mud on the legs, especially if it contains irritant substances like salt, lime, or alkali. It is said that clipping the heels predisposes to scratches. The symptoms are local heat, swelling and tenderness in the skin, roughness to the overlying hair, stiffness, and lameness. Unless treatment is prompt, the cracks widen, become infected, and pus forms. The edges of the wounds present a gum-like secretion, which soon dries and leaves a dirty appearing surface. In applying treatment the aim should be to remove the irritating cause and hasten wound-healing by keeping out infection. The part must be thoroughly dried by the use of hot bran or sawdust packs and a light, clean bandage applied. The animal should be allowed a few days' rest and provided with a laxative diet, to which may be added a tablespoonful of artificial Carlsbad salts three times a day to regulate the bowels.

Grease heel is a very troublesome affection of the skin often associated with peculiar fungus growths, called "grapes." It may involve any part of the legs covered by the long hair from the knees and hocks down. Heavily feathered, coarse skinned, sluggish horses are predisposed to grease. The causes are similar to those of cracked heels, the difference in the symptoms being due to the character of the secondary invading micro-organisms. The chief symptoms are a moist, greasy feel to the skin of the region, an offensive discharge, grape-like outgrowths, falling of the hair, and stiffness. In bad cases the malady extends to the horny frog, which becomes soft and throws out canker-like growths. When instituting treatment hygienic measures are important, but require medicinal aid to establish a cure. Internally, ½-ounce doses of

Fowler's solution of arsenic night and morning are indicated. If proud flesh forms it may be burned off with a hot iron. Treatment suitable for one patient may be entirely ineffective for another, so each case must be handled on its own merits. A dressing made of 1 ounce of vaselin, 2 drams of zinc oxid, and 20 drops of iodized phenol has been recommended by veterinarians with wide practical experience.

Ulcers are old wounds with no tendency to heal. They are often called "running sores." A careful examination will usually reveal some foreign irritating material, which must be removed before healing will take place. When they occur over a bone it should be exposed and scraped. Scars are always left when ulcers heal.

Fistulæ are abnormal, tube-like passages. When they have but one opening they are termed "blind fistulæ." A true fistula is one that discharges the secretion of an organ. In the horse such a fistula is most common as a result of injury to the duct of one of the salivary glands. The continuous dripping of the saliva often makes healing impossible, and permanent relief can be obtained only by actually destroying the function of the gland with injections of iodin.

An **open joint** may be defined as an external wound which communicates with a joint and allows synovia to escape. It often occurs as a result of a puncture wound caused by a fork-tine or similar pointed object. It is dangerous, because infection gains entrance to the joint cavity, where absorption of poisons is very rapid. Treatment must be immediate to prevent serious consequences and had better be left to a veterinarian. The wound ought to be flushed out with a non-irritating antiseptic solution. A bandage should be applied, or the skin wound covered with collodion, if it is thought that no pus organisms have gained entrance. In case pus forms in quantity the prognosis is doubtful.

WOUND INFECTION DISEASES

A number of diseases are directly due to wound infection. Besides those caused by specific micro-organisms, like anthrax and tetanus, there are recognized the following: suppuration, abscess formation, wound fever, septicemia, and pyemia.

Suppuration means the formation of pus. It is caused by infection with one or more of the pus-producing micro-organisms, like Staphylococcus pyogenes aureus, Staphylococcus pyogenes

albus, Streptococcus pyogenes, or the Bacillus pyocyaneus of blue and green pus. Pus acts as a mechanical agent to bring irritating substances from the depths of wounds. When left in the tissue any length of time it has the power to dissolve them, so ought to be removed promptly.

Abscess formation is one of the most common wound infection diseases. An abscess is the local accumulation of pus in the tissues. There are "hot abscesses" and "cold abscesses." The hot abscess is always very sensitive to pressure and is accompanied by the other symptoms of inflammation—viz., heat, redness, and swelling. Cold abscesses are gradual in development and non-sensitive. The skin is adherent over the surface of abscesses. Advantage is taken of this fact in differentiating between abscesses and other swellings. In the majority of cases the abscess has developed so far by the time it is noticed that attempts to absorb or "scatter" it are futile. However, in the early stages the daily application of tincture or ointment of iodin will be found beneficial. The application of a light blister or a stimulating liniment assists absorption. If acute inflammatory symptoms are present, neither of these should be used. Usually the best results are obtained by applying a poultice to the "gathering" to bring it to a head quicker than naturally. For this purpose "Denver Mud," antiphlogistin, or a flaxseed poultice, with an antiseptic added to keep down injurious germ growth, is useful. As soon as the abscess softens in the center and the hair falls out it is ready to be opened. This is done by making a liberal incision to allow free draining of the pus.

Wound fever includes a rôle of symptoms, among the principal of which are elevated body temperature, loss of appetite, and deranged digestion. The main treatment consists in the application of antiseptics directly to the wound.

Septicemia means the presence of bacteria and their poisonous products in the circulating blood. It is commonly known as "blood-poisoning." This disease may follow extensive wounds that have been neglected. As a sequel to decubitis (bed-sores) it complicates cases in which paralysis of the limbs renders standing impossible.

Pyemia is that wound infection disease in which pus organisms are found in the circulating blood. It leads to secondary multiple abscess formation in the internal organs and generally throughout the body.

CHAPTER XIII

COMMON UNSOUNDNESSES AND VICES[1]

THERE are a great many *unsoundnesses*, *abnormalities*, *malformations*, *deformities*, *blemishes*, and *vices* that should be looked for when conducting a soundness examination. In this chapter some of the more common ones will be described, others are covered in connection with diseases of special groups of organs.

A horse is either sound, serviceably sound, or worthless. *Perfectly sound horses* are rare, for few are free from some trivial defect or other. *Serviceably sound horses* are those that have no disease, deformity, or vice which will interfere with their utility. Great differences of opinion exist as to what is meant by serviceable soundness on account of the different standards of the examiner. *Worthless horses* are those that are permanently incapacitated for service from any cause whatsoever.

Acquired unsoundnesses do not disqualify a horse for breeding purposes. In this class are included all troubles not caused by prenatal influences, such as distorsions, deformities, or blemishes due to accident. When serious they depreciate the sale value.

Hereditary unsoundnesses are transmitted from parent to offspring, and should always be considered sufficient evidence to disqualify the horse as a sire or dam.

POLL-EVIL

Poll-evil is a hot, painful swelling which forms on the top of the neck immediately behind the ears. The enlargement contains pus, or a straw-colored fluid, and usually involves the large mucous

[1] The student will find it helpful to outline an exercise in soundness examination suitable for use when buying horses as a practical means of applying what he has learned in the classroom. The diseases, unsoundnesses, and vices mentioned in this and other chapters should be grouped in score-card form according to their location. The discount to be allowed for the various disqualifications will require very careful consideration and will depend upon how much they effect the serviceability of the horse.

bursa situated over the first vertebra. A bruise or other injury is the most frequent cause of poll-evil. External applications of liniments and poultices fail to remedy the condition. Lancing the swelling on each side does not answer, for it is impossible to

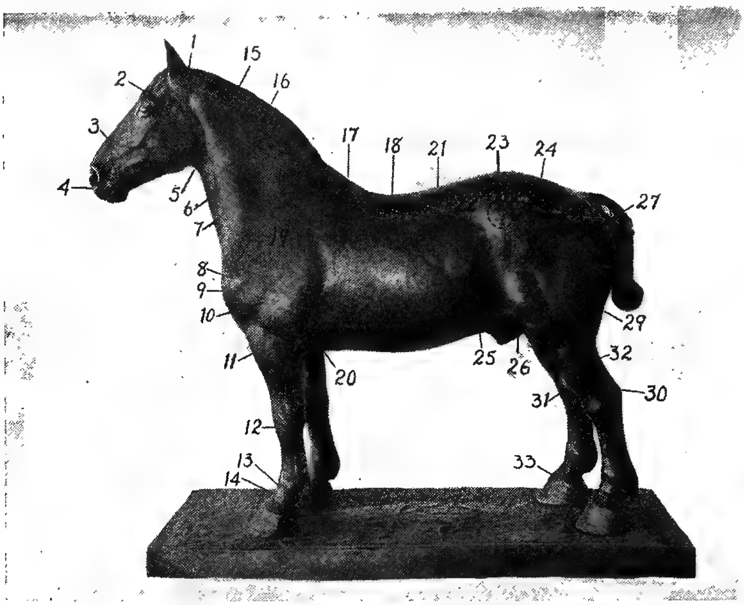

Fig. 48.—Chart showing "The Points": 1, Poll; 2, forehead; 3, face; 4, muzzle; 5, throat-latch; 6, windpipe; 7, jugular groove; 8, point of shoulder; 9, chest; 10, arm; 11, forearm; 12, knee; 13, fetlock; 14, pastern; 15, neck; 16, crest; 17, withers; 18, back; 19, shoulder; 20, elbow; 21, loin; 22, coupling; 23, hip; 24, croup; 25, flank; 26, stifle; 27, hip-joint; 28, thigh; 29, quarter; 30, point of hock; 31, hock-joint; 32, gaskin or lower thigh; 33, coronet. (Photograph of model designed by Geo. F. Morris.)

get complete drainage. Consequently, it will be necessary to have the surgeon incise the enlargement lengthwise and carry the cut over the prominence of the poll and down on to the forehead to insure permanent relief. Injections of a specially prepared bacterin have proved helpful in hastening recovery.

FISTULOUS WITHERS

Fistula of the withers is a disease similar to poll-evil, but is located at the withers. It is commonly called "thistlelow." Bruises have been thought to be the cause in many cases. In view of the fact that pus is often present, even when there is no evidence of a previous skin wound, it seems reasonable to believe

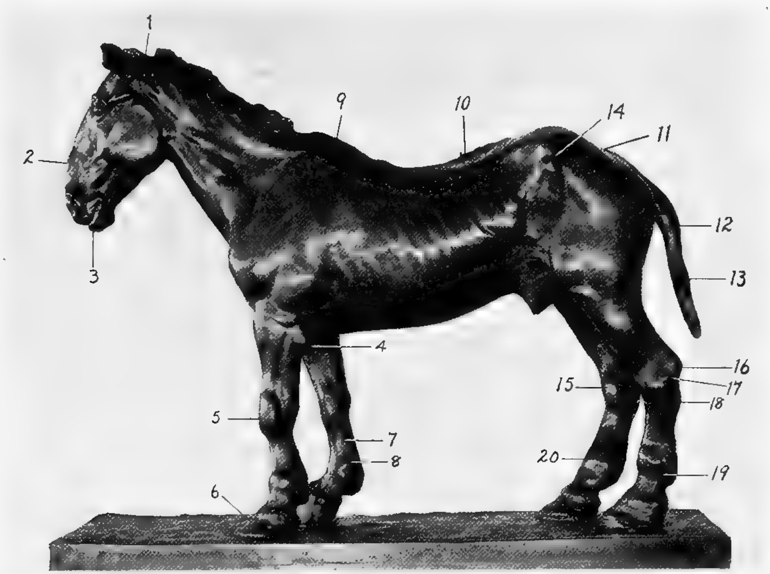

Fig. 49.—Chart showing various unsoundnesses and defects: 1, Poll-evil; 2, Roman nose; 3, pendulous lip; 4, shoe boil; 5, enlarged knee; 6, founder; 7, splint; 8, windgall; 9, fistulous withers; 10, sway back; 11, droop rump; 12, rattail; 13, crooked tail; 14, broken hip; 15, bog spavin; 16, capped hock; 17, thoroughpin; 18, curb; 19, cocked ankle; 20, enlarged fetlock. (Photograph of model designed by Geo. F. Morris.)

that the pus organisms must have been brought by the blood. Unless the pus is evacuated it may burrow between the muscles and break out on the shoulder. Fistulæ may be very slow in forming. A deep-seated abscess cavity of many months' standing with no external signs of its presence has been found in a horse in the dissecting laboratory. A hot, painful swelling appears on one

or both sides of the dorsal vertebræ at the withers in typical cases. A surgical operation to allow the accumulated pus to escape, and to remove thickened tissue and necrosed bone, is the only treatment recommended for permanent relief. The operation should be delayed until the acute symptoms of inflammation have subsided. Caustic applications to destroy the diseased tissues should be used only on the advice of the attending veterinarian. In most cases success follows proper treatment, but only after several weeks. If the animal has little value, it will be well carefully to consider the advisability of going to the expense in loss of time and the feed required before it will be fit for return to service.

SHOE BOIL

Shoe boil develops at the point of the elbow as a soft, flabby swelling. Chief among the causes of this disease is pressure from the heel calk of the shoe. As a rule, it results in lameness only when acute inflammation is present and when its size interferes with movement. At best a shoe boil is unsatisfactory to treat. If discovered while yet small, it may be prevented from further development by daily applications of tincture of iodin and the use of the shoe-boil boot or roll, which is designed to be strapped about the pastern to keep the heel from pressing upon the elbow while the horse is in the recumbent position. Large shoe boils are only removable by the knife. As the skin is thin and tightly stretched at the elbow when the joint is flexed, it is difficult to get the operation wound to heal. Mention may be made of the ligature as a means of removal. It is passed around the neck of the swelling and tightened each day until the circulation is stopped and the whole mass undergoes necrosis and drops off.

CAPPED HOCK

Capped hock is a soft enlargement that develops at the point of the hock. It may be hot and painful, but is usually not inflamed and non-sensitive. A fluid of a serum-like nature will be found if the enlargement is punctured. This is, however, seldom a wise procedure, for most cases are amenable to simpler treatment, besides the sac rapidly refills. Little relief follows the application of a blister. Painting the enlargement each day with tincture of iodin helps to diminish it. Many cases fail to absorb even with skilful attention and the capped condition remains as an eyesore.

If it does not interfere with the work of the horse it need not be considered a serious unsoundness.

BOWED TENDONS

The tendons situated behind the cannon bone, in both the front and hind legs, are subjected to severe strains from violent efforts or sudden jerks. When the injury is pronounced more or less swelling and soreness is present. The swelling usually extends from the knee down to the fetlock, and occasionally even farther. It is always characterized by heat and is often quite painful. A lameness develops in proportion with the severity of the injury. The tendons relax and bulge or bow out. They may not resume their normal position even after the acute inflammation subsides, in which case the bowed condition remains and is considered a permanent unsoundness. Treatment consists in the application of blisters. If these fail to bring results, the parts may be strengthened by the use of the firing iron.

COCKED ANKLE

A horse is said to have a cocked ankle when he "knuckles over" at the fetlock joint. This occurs when the slope to the long pastern is rendered less oblique and the bone assumes a more upright position than normally. Close examination shows inability to extend the joint to the usual degree. It is a deformity caused by structural changes in the tendons and ligaments about the joint

Fig. 50.—Cocked ankle. This deformity is also known as "knuckling."

from heavy work of all kinds. In young horses it may be the result of weakness in these parts. If the cause of the condition can be found it should be promptly removed. Special shoes with low heels and long toes help in many cases. As in other similar diseases, the actual cautery may be given a trial (Fig. 50).

WINDGALLS

Windgalls are soft, non-sensitive, puffy swellings filled with synovial fluid. They appear about the fetlock joint and other parts where tendon-sheaths are located. These enlargements vary in size, from a hazelnut to that of a hen's egg, or larger. In old horses they are a sign of hard work. Foals develop windgalls from general weakness, but they disappear without treatment when the animals get older. If no inconvenience is given the horse, little attention is required. They rarely diminish the usefulness of the animal unless they become indurated and converted into fibrous tissue. Little success follows the removal of the fluid from windgalls. Massage and bandaging are helpful in reducing them. It is not wise to apply a blister with the hope of getting absorption of the serous fluid, as experience teaches that no permanent benefit results from such treatment.

CURB

Curb is a swelling, or bulging backward, at the back of the hock, about 6 inches below its point. It is caused by anything that brings about a thickening in the ligament, tendon, or skin of this region, so as to cause a deviation in the straight line that normally extends from the point of the hock to the fetlock (see Fig. 49). To detect a curb the examiner should view the leg in profile from both sides. A "curby hock" is often found in an animal with a tendency toward "sickle hocks" (see Fig. 56). When lameness results from curb use a high-heeled shoe to remove strain from the part. Rubbing the enlargement daily with a flat bone helps to reduce the enlargement. The actual cautery must be resorted to not infrequently for removal of the lameness.

STRINGHALT

Stringhalt is a spasmodic jerking up of one or both hind legs. It is most evident when the horse is walking, turning, or backing. Nothing positive is known about its origin. It may usually be cured or greatly remedied by a surgical operation on the lateral extensor tendon. An incision is made over the tendon on the outside of the leg just below the hock and about 2 inches of the tendon is removed.

TUMORS

Tumors are new growths which appear at times in various tissues of the body from no apparent cause. They may be either benign and slow in development or malignant and spread very rapidly. Benign tumors remain localized and are not dangerous unless vital organs are involved. Warts are benign tumors. They occur on the thin parts of the skin. To remove warts pull or twist them off, cut them away with a knife, or burn them with a hot iron. All malignant tumors should be excised completely and early with the surgeon's knife, in order to prevent them from encroaching upon neighboring tissues and spreading to other parts of the body. As a rule; caustic agents are to be employed to destroy tumors only on expert advice, for they tend to cause them to spread and favor their growth.

A common form of malignant tumor, occurring in white and gray horses, is known as melanosarcoma. It is always black in color and contains a large amount of melanin, the pigment found in the skin.

CANCERS

Cancers are malignant tumors composed of epithelial and connective tissues. They have a tendency to persist and grow down into the surrounding tissues. They are found either on the surface epithelium or in the epithelial cells of glands. The causes are various and numerous irritating agents. Recent experiments go to show that cancers have an infectious origin and can be transplanted in animals of the same species. Cancers occur most frequently on the head and penis of the horse. A diagnosis is made by sectioning and staining pieces of the tissue, or by applying the Abderhalden test to the blood-serum of the patient. Treatment consists in complete and early excision whenever practicable.

DEFECTIVE CONFORMATION

Defects in conformation and malformations of various kinds should be avoided in horses used for breeding purposes. Although these may not be of a nature to be classed with the unsoundnesses, they do reduce the value of the animal. Some are inherited, others are acquired.

Badly formed limbs reduce the efficiency to a greater extent

than any other defect in conformation. To detect these variations from the normal, the horse must be inspected in the standing position from the front, behind, and the sides. The commonest defects noticeable when the examiner is stationed either directly in front or behind the horse are "base-narrow" and "base-wide" deviations. The first gives too little support upon the ground, while the latter tends to cause paddling and interfering.

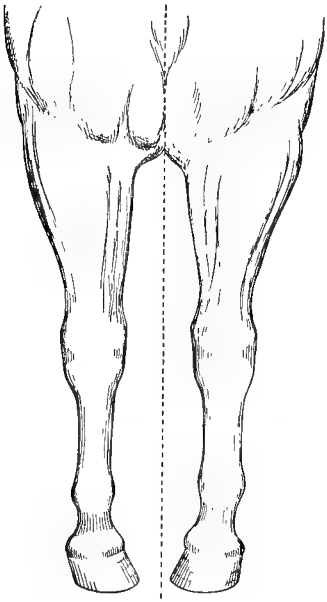

Fig. 51.—Pigeon-toe.

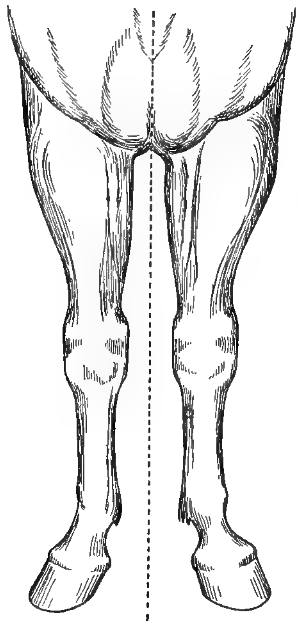

Fig. 52.—Splay-foot.

In the fore limb is seen the "pigeon-toed" position, where the limbs are straight to the fetlocks, but the pasterns and feet turn in (Fig. 51). When the toes point obliquely outward there is formed that awkward defective conformation termed "splay-foot" (Fig. 52). Viewing the fore limbs in profile, we may find that the legs from the knees downward are placed too far under the body, and the knees are bent backward; this is termed "calf-knee" (Fig. 53). Backward deviation, where only the cannon bone is affected

and the horse stands bent forward at the knees, is called "goat-knee" "buck-knee," "over-in-the-knees," or "knee-sprung" (Fig. 54). Foals from birth may be knee-sprung, or even unable to stand at all, as a result of contracture in the flexor tendons. Good results have been obtained by the author in these cases by applying extension splints to the leg. It may be necessary even to

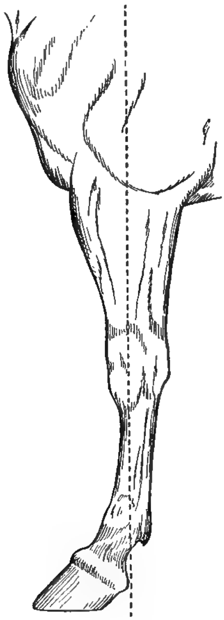

Fig. 53.—Calf-knee.

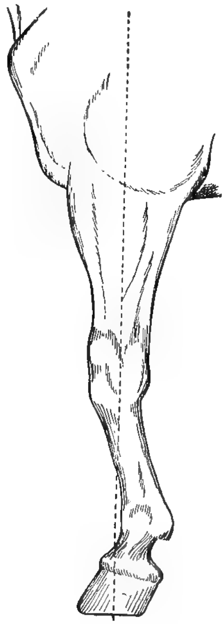

Fig. 54.—Goat- or buck-knee.

section the deep flexor tendon in part or completely to get relief, if the contractions are very marked.

In the hind limbs we may observe the "cow-hocked" position, where the hocks are too close together and turn toward each other, while the feet are widely separated and the toes turn outward (Fig. 55). From the side may be noticed the forward deviation, termed "sabre-leg" or "sickle-hock," in which the hock-joint is flexed too much, the foot placed too far forward under the body, and the pastern too sloping (Fig. 56).

Other defects of and abnormalities in conformation undesirable to propagate are a slim head, small jaws and muzzle, narrow chest, loose coupling, roach-back, sway-back, low withers, ewe-neck, droop

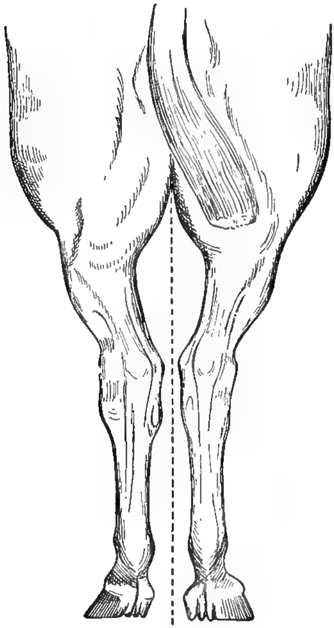

Fig. 55.—Cow-hock.

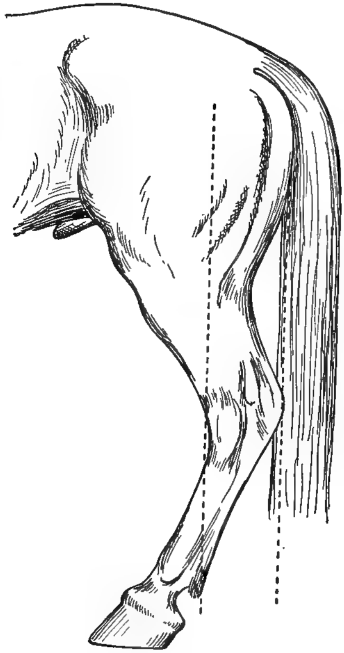

Fig. 56.—Sickle-hock or sabre-leg.

rump or croup, weak stifles, abnormally long legs, and certain defects in the mouth and feet mentioned in other chapters of this book.

COMMON VICES

Viciousness is shown by kicking, biting, switching, etc., and indicates an irritable disposition not desirable in animals used for breeding purposes. These vices also reduce the value of horses by rendering them dangerous to attendants.

Cribbing and **windsucking** are considered here as vices. Some authorities class both of them with the unsoundnesses. In any

event they are worthy of especial mention, if for no other reason than that a horse with either habit is usually a hard keeper and disagreeable to have about the premises.

Other vices of a highly objectionable nature, to be detected when the horse is in the stall, are halter pulling, weaving, rolling, crowding the attendant, blanket-tearing, and pawing. When hitched or ridden we may discover tendency toward shying, balking, running away, and line hugging.

CHAPTER XIV

METHODS OF RESTRAINT AND COMMON OPERATIONS

TWITCHING

The twitch is the most satisfactory and convenient way to restrain the horse for common operations. It is made by passing a loop of cord through a hole bored in one end of a round stick (Fig. 57). The loop should be large enough to admit the closed fist.

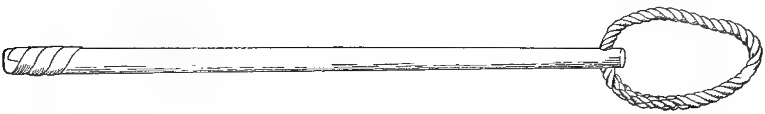

Fig. 57.—A homemade twitch.

To apply the twitch the operator passes his left hand through the loop of the cord and firmly grasps the upper lip of the horse. With his right hand he twists the stick of the twitch until the lip becomes tightly squeezed by the cord. It acts by squeezing the lip until the pain produced is sufficient to divert the animal's attention. It is inhuman to twist the twitch tighter than is absolutely necessary, besides there is danger of causing paralysis of the lip.

HOPPLING

Hopples are used to tie the feet together to secure the horse in the recumbent position for operations. They have the advantage over any other method of restraint in that they can be applied quickly and serve to securely cast the animal.

English hopples are a form of casting apparatus in common use. They consist of four strong leather straps that are buckled to the pasterns. These are all connected with a chain, which can be released by simply withdrawing a small bolt. The disadvantage of these hopples is the danger of breaking the back or a bone in a limb during efforts of the animal to gain freedom. If an assistant holds the head with the nose turned up this accident may be avoided.

Knowles' casting harness is simple in construction, besides being cheap, durable, and easy to apply (Fig. 58). It consists of a wide web collar, from which ropes extend backward on each side to the hind pasterns. The free ends of the ropes are used to tie the feet

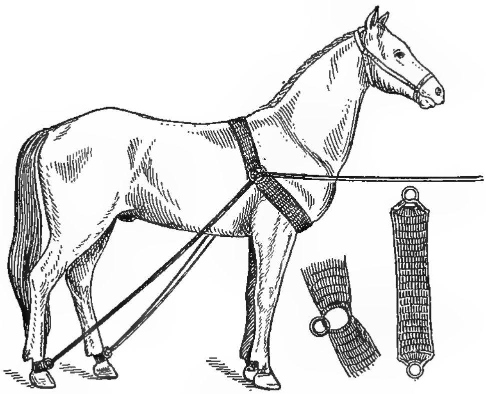

Fig. 58.—Knowles' casting harness.

and legs after the animal is thrown. An improvised harness for emergency use to answer the same purpose can be constructed on this plan from a long rope.

ANESTHETIZING

Anesthetics are used to render a part or the whole of the body insensible for the purpose of performing operations with greater dispatch and more safety to both the operator and the patient. Local anesthetics are employed when the part operated upon is limited in area. General anesthetics produce a loss of consciousness, sensation, and motion. The muscles relax and the patient lies motionless when anesthesia is complete. It should be understood that accidents and dangers attend general anesthesia of the horse. Chloroform and ether are the chief anesthetics used. Either of these may be given while the horse is standing, by means of a "mask" or "inhaler" that slips over the muzzle and straps around the face. More often the animal is thrown, one nostril is plugged with cotton, and he is made to inhale the fumes of the

anesthetic through gauze stretched across the other nostril. About 6 ounces of chloroform, given over a period of some twenty minutes, are necessary to place the horse fully under its influence. Chloral hydrate has many advantages as a narcotizing agent. It is given in aqueous solution either intravenously or by the mouth. The dose varies from 20 to 70 grams. Cocain is the most popular agent for producing local insensibility to pain. It is injected hypodermatically over the nerves of the part to be operated upon. As a means of finding the exact seat of lameness it is especially valuable.

SLINGING

Slings are useful to support the animal in the standing position when he is unable to stand without assistance. If the horse refuses to assist himself and hangs in the slings they should not be used.

There are a number of different types of slings on the market. The older makes have a wide canvas girth, which passes under the body and presses on both the sternum and the abdomen. They are objectionable for the reason that too much pressure is brought to bear on the abdomen when the horse throws his weight into the slings. With pregnant mares this is a decided disadvantage, as it may result in abortion. In any case, the abdominal viscera are pushed forward and press on the diaphragm, which, in turn, compresses the lungs so that respiration is interfered with.

The newest type of sling is so constructed that the weight is borne by a relatively narrow girth and breast-piece, which press only on the sternum and pectoral muscles, and has a breeching in which the horse may rest the hind quarters with safety and comfort. All the parts of a good sling should be adjustable by means of straps. A self-locking chain pulley is the most satisfactory method of regulating the height. It should be suspended from an overhead beam or ring. Such an arrangement is so easy to operate that a small boy can raise a heavy animal without assistance.

CASTRATING

Castration is the unsexing of the male and consists in the removal of both testicles. It is resorted to very frequently to render the horse more tractable. The operation is not attended with danger if performed while the horse is young, unless there is a hernia of the bowel into the inguinal canal or scrotum, or the usual

precautions to exclude wound infection are neglected. Perhaps the spring is the best time of year for castration, as the flies are less prevalent and the weather is suitable.

The testicles of a colt usually descend into the scrotum shortly after birth. Too early removal interferes with the development of masculine characteristics. It is the custom to postpone castration until the colt is at least one year old. Colts are less difficult to handle on account of their size, and are more resistant to wound infections than mature stallions. The operation may be performed either in the standing or recumbent position. Fractious animals had better be thrown and securely tied to prevent injuring themselves or the operator. Further advantages are that the field of operation can be more thoroughly cleansed and subsequent wound infection prevented.

The emasculator and ecraseur are the two instruments given preference in America for castrating. Undoubtedly the improved emasculator is used more generally. It has the advantage of simplicity in construction, so is easy to sterilize and use. It is designed to crush the tissues before it cuts them and thus prevents serious hemorrhage. The ecraseur has a chain loop, which is gradually screwed down over the spermatic vessels by turning the handle.

The clam is an instrument used for compressing the cord. It is composed of two pieces of flat steel or wood, which have serrated edges and are united by a joint. Up-to-date operators do not favor the use of the clam, because there is greater danger that pus-producing organisms will be retained.

In order to insure success in castrating animals there must be provided:

(1) Cleanliness, which includes a careful washing and disinfection of the field of operation, the hands, and sterilization of the instruments.

(2) Good drainage for the wound, so as to prevent pus accumulations. To insure this, a large, free opening should be made in the skin and other coverings of the testicle.

(3) Exercise, to consist of an hour's walk at the halter for the first few days after the operation, then brisk trots. Colts turned out to pasture immediately following the operation recover quicker than those confined to the stable, where opportunity to infect the castration wound is greater and daily exercise is limited.

Castration of animals exposed to or infected with disease had

best be postponed. The operation should not be performed at the time other surgical operations are executed.

Scirrhus cord results if the spermatic cord is left too long at the time of castration. This is a condition in which infection occurs and the stump of the cord becomes inflamed, hardened, and discharges pus more or less continuously. It is generally very troublesome, for adhesions take place and interfere with the normal movement of the limbs. The only permanent relief is complete removal of the diseased tissues.

Ridglings, or **cryptorchids,** are male animals in which one or both of the testicles fail to descend into the scrotum. They exhibit all the traits of entire males but are not satisfactory sires. For these reasons they should be castrated. The operation is more dangerous than ordinary castration, as it usually requires an artificial opening into the abdominal cavity. This exposes the peritoneum to infection and may result in peritonitis. If this disease does develop, rapid death is likely to follow. Every precaution must, therefore, be taken to maintain surgical cleanliness when operating upon a ridgling.

SPAYING

Spaying is performed to remove the ovaries (ovariotomy). It is attended with the same danger that accompanies ridgling castration. Mares are spayed to alleviate vices caused by diseases of the ovaries. The animal should be carefully prepared for the operation by having been kept on a scant diet for at least twenty-four hours beforehand. There are many dangers incident to ovariotomy, so none but a skilled veterinary operator should attempt it. It may be said that an incision is made in the wall of the vagina through which the ovaries are removed.

CATHETERIZATION

The catheter is a tube-like instrument used to remove the urine from the bladder. Catheterization is the operation of passing the catheter. Resort is had to this method of relief when the animal is unable to urinate. In the stallion, or gelding, catheterization is more difficult than in the mare, whose urethra is shorter and of greater diameter. Some trouble may be experienced when the point of the catheter arrives at the bend of the male urethra as it curves over the ischial arch. By working with the forefinger and

at the same time gently but firmly pushing the catheter upward the difficulty may be overcome. The bladder of the mare may be emptied by pressing upon it with the hand inserted in the rectum.

FIRING

Firing is the application of a hot iron or the thermocautery to a part for the purpose of bringing more blood (nutrition) to it. It has for its object the conversion of a chronic into an acute inflammation. When properly used it hastens nature's processes and makes the animal suitable for work sooner than would otherwise be the case. A more detailed account of the kinds, uses, and manner of applying this method of cautery is given in the section on Treatment for Bone Diseases. For cases of sprained tendons and ligaments after acute inflammatory symptoms have subsided it is very useful to strengthen the weakened tissues.

KILLING

Killing a horse is a somewhat unpleasant duty which every horse-owner may be called upon at any time to perform. The most effective way is to shoot the animal. The place where the bullet should enter is accurately located at the point of intersection of two imaginary lines drawn from the bases of the ears to the opposite eyes. Even with a .22 caliber firearm the animal will drop dead, without a struggle, on the spot upon which he has been standing.

REDUCING RUPTURE

A rupture is a condition in which a loop of the bowel has escaped from the abdominal cavity and lies superficially beneath the unbroken skin. The resulting enlargement yields to pressure, and may be reduced by working the contents through the hernial ring. Rupture occurs most frequently at the navel, but is not rare in the scrotum and at points along the abdominal wall where there is a weak spot. A kick or a blow are common causes of hernia after birth. At the navel it often results from a weakness left when the navel cord became detached, and is known as *umbilical hernia.* Ruptures are not uncommon in colts. They frequently outgrow the trouble, so it is wise to defer surgical interference until they are at least one year old, unless there is danger of strangulation by pressure. When an operation is deemed necessary an expert surgeon should be summoned, as adhesions may have occurred that

must be broken down in a skilful manner to make the operation a success.

DOCKING

Draft horses are sometimes subjected to this inhuman operation, which is rapidly falling into disrepute and is now unlawful in most states. Thirty years ago fashion demanded docking for heavy harness horses in order to make them appear "smart." In cases where tumors occur on the tail, or the animal switches and kicks a great deal, it may be removed either by the surgeon's knife or by the docking shears designed especially for this purpose. Restraint is accomplished by the twitch and the side-line.

NICKING

Under this term may be mentioned the operations for correcting curvature of the tail, and the prevention of the gripping of the reins by the tail. The first operation is the simpler, and consists in simply cutting across the levator or extensor muscles of the side toward which the tail is curved. It is performed subcutaneously under the control of the twitch and side-line. If the operation is successful, the tail will be carried in a normal manner after the wound heals. The operation to prevent gripping the reins is more extensive and usually requires that the animal be thrown. It consists in dissecting out and removing about 5 inches of the depressor muscle on each side of the inferior surface of the tail.

UNNERVING

Unnerving is performed to relieve pain in a part, to prevent lameness in a limb, or to stop motion, as in the "cribbing" operation. The operation is technically termed *neurotomy*, and consists in severing or actually removing a portion of a sensory nerve. It should always be performed under either local or general anesthesia for it is painful.

Neurotomy should be the last resort for the relief of lameness. When the part is deprived of sensation there is always danger of breakdown in the limbs; besides, if an injury occurs, the animal is not aware of it and serious results follow which may jeopardize the life of the animal.

The commonly performed neurotomies are digital neurotomy, which has for its object the relief of navicular lameness in cases where plantar neurotomy is not deemed necessary or advisable;

plantar neurotomy, for the relief of navicular or ringbone lameness, or other non-infectious, painful conditions below the fetlock; median neurotomy, to relieve lameness due to disease of the fore limb, so located that it cannot be overcome by plantar neurotomy; sciatic and anterior tibial neurotomies, for the destruction of sensation in the hock and parts distal thereto to relieve otherwise incurable spavin lameness and diseases of the tendons.

TRACHEOTOMY

Tracheotomy is an operation to provide a direct entrance for air into the trachea. It is performed for the following purposes:

To avert suffocation threatened by swellings or other obstructions in the upper air-passages; to restore to usefulness animals that have difficulty in breathing produced by stenosis of the upper air-passages; and to remove foreign bodies from the trachea.

The operation is best performed on the standing animal with the head extended. A portion of two adjoining tracheal rings is removed. There is then inserted a special trachea tube, with a fine wire-gauze covering to prevent dust particles in the air from passing through. This tube is to be removed and cleansed daily as long as its use is necessary.

ARTIFICIAL INSEMINATION

The imprĕgnator is used in horse-breeding as a practical and satisfactory means of breeding mares that have been difficult or even impossible to breed by direct service. As a means of breeding several mares at one service of the stallion, it has extended his use to more mares than would otherwise be possible.

In Bulletin 93 of the Oklahoma Experiment Station, Dr. L. L. Lewis discusses the various forms of instruments employed for artificial insemination and their methods of use. He emphasizes the necessity of keeping all instruments scrupulously clean. As the sperm cells are very abundant in the semen, it is not necessary to place a large amount in the womb. Experiments show that contact with the air seems to have little effect upon the vitality of the sperm cells. Direct sunlight is injurious to them, and semen left in the sun soon loses its vitality. The life of the cells is short even when protected, as in normal copulation, so an effort must be made to introduce the semen into the womb without unnecessary exposure or delay.

CHAPTER XV

DISEASES OF THE FOOT AND SHOEING

LAMENESS

Lameness has been defined as any irregularity in the gait. It is the most serious impediment that may befall a horse because of its frequent occurrence. From a diagnostic point of view it is necessary to distinguish between a "swinging leg lameness" in which the pain emanates from the shoulder or the hip and a "supporting leg lameness," in which the lesion is in the knee, hock, or lower part of the leg.

To detect lameness the examiner should first get a full history of the case. Then he ought to observe the animal at rest. In severe cases he may recognize that pain exists by the horse pointing, frequently raising the affected limb, or placing the affected part in an unnatural position for relief. Next the animal should be trotted past, away from, and toward the observer. The attendant must not take too short a hold on the halter shank, as it would interfere with free movements. The head and hips are to be closely watched at this time, as their movements are a reliable guide in locating the seat of lameness.

If lame in the right fore leg, for example, the head will "nod" or "bob" when the left or sound foot is planted on the ground, while the head jerks up at the moment the right or lame foot touches the ground.

When lameness exists in both fore legs the action is stiff and stilty, the natural free stride is shortened, and the feet are raised but little from the ground. Almost always the hind legs are picked up higher than normally, the shoulders seem to be stiff, and the head is carried higher than is usual.

Lameness behind may be noted by a dropping of the hip opposite to the one in which soreness exists when the horse is trotted from the observer.

Should there be lameness in both hind legs the stride is shortened and the gait awkward, the fore legs are not advanced in front of the body and are raised higher than usual, and the head is

lowered. It is difficult or impossible to back a horse lame in both hind legs.

Horses lame in both fore and hind legs show a waddling gait behind that may be mistaken for loin or croup lameness. This peculiar motion is simply due to the fact that the hind legs are unduly advanced under the body for their own relief or that of the front legs.

Shoulder lameness is shown at the time the leg is advanced, for then pain is felt. It is a typical swinging-leg lameness and the toe is dragged. Many horse owners believe that this form of lameness is very common, but it really is quite rare.

In the majority of cases it is not very difficult to detect the limb in which lameness exists, but experience and keen insight are required to locate the exact seat of the trouble. Remember that the largest percentage of lamenesses are located below the knee and hock, and that the foot is involved much oftener than any other part. If the existence of a spavin is suspected, give the horse the "spavin test." Palpation for the exact location of the soreness is a valuable aid in diagnosis, but care should be taken to distinguish between flinching due to nervousness and that due to inflammatory soreness. The presence of one or more of the cardinal symptoms of inflammation are reliable guides in the diagnosis of lameness. By placing the lame leg in its normal position and carefully comparing it with the sound leg for anatomic changes a more accurate diagnosis can be made. In obscure cases resort may be had to cocain injections over the sensitive nerves of the suspected part for correct diagnosis.

Unscrupulous dealers practice certain tricks to cover up lameness. Among the common ones are the use of a curb bit and a close hold on the leading rein to keep the head raised and to prevent "nodding." By paring down the sound foot to the "quick" and replacing the shoe so as to make both feet tender, a horse slightly lame may be made to appear normal.

In the treatment of lameness, rest is the principal requirement to restore the horse to perfect soundness or usefulness. The usual means of providing rest are the use of a specially constructed shoe, the application of a blister, trimming the hoof, turning out to pasture. These and other methods of treatment are to be employed only after each case is studied and the exciting cause of the lameness has been removed.

QUITTOR

A quittor is a wound of a fistulous nature occurring at the hoof-head. It is the result of an injury to the structures covered by the horny box. Nail-pricks, punctures of the sole or frog, bruises, and suppurating corns are common exciting causes. The irritating substance induces inflammatory changes. There may be noted the attendant symptoms of inflammation—viz., heat, swelling, redness, and pain. Lameness is very great, especially in the early stages, as the pressure of the inflammatory exudate on the sensitive nerves of the pododerm is intensified by the fact that little expansion can take place in the hoof. One or more discharging sinuses which communicate with the infected tissues may be observed in the swelling at the coronet. Treatment should first be directed toward locating and removing the cause. An examination of the lower surface of the foot may reveal discolored horn. If found it must be cut away at once to allow the accumulated pus to drain out. Afterward a 1 : 500 solution of bichlorid of mercury may be injected under pressure into the sinuses. If the fistula fails to show improvement with this treatment, an operation to remove the necrotic tissue in the depths must be performed.

CORNS

A corn is a bruise of the sensitive tissue, lying directly above that part of the sole between the bar and the wall. This is the spot most liable to injury, because the horny covering is thinnest and the heel is placed on the ground first, so receives the most concussion. Corns usually occur only on the inside of the fore foot. Fast work on hard and rough roads, flat soles, weakened bars, and poor shoeing predispose to corns. If a simple corn is present there may be but little lameness apparent, unless the horse steps on a stone or other hard substance and bruises the part again. When the horn of the buttress is examined it will show red discoloration, and pain will be caused if this spot is tapped with the hammer. It is not advisable to pare this horn away in simple cases. If pus has formed, a "suppurating corn" occurs. In this case the shoe should be removed and an outlet for the pus made on the sole surface of the foot, or it will burrow in the direction of the line of least resistance and discharge at the coronet (quittor). A three-quarter shoe is best for an ordinary non-suppurating corn, as it removes pressure from the inflamed part and relieves lameness.

THRUSH

Thrush results from lack of care to the feet. It is characterized by an abnormal secretion from the cleft of the frog. When the horse is allowed to stand in a filthy place where much moisture is present the horn becomes soft and loose, its pores open up, and infection enters. The symptoms are the discharge of a dark-colored pus, with a very offensive odor. This may later become profuse and undermine the horn of the frog. There is some heat noticeable in the affected foot and the hoof dries out and gets brittle. Treatment consists in providing a clean, dry stall. All the loose portions of horn should be pared away so that a dressing may be applied directly to the diseased parts. After thoroughly washing and drying the foot, powdered calomel, copper sulphate, or burnt alum may be packed into the crevices.

FOUNDER OR LAMINITIS

This is a painful disease, resulting from congestion of blood between the sensitive and horny laminæ of the feet. It is often called "water founder," from its appearance soon after watering a very hot or tired horse. The fore feet are most commonly affected.

Acute laminitis is the form in which founder first appears. Its causes are overfeeding, or feeding too soon after violent exercise; large draughts of cold water when very warm; concussion from excessive driving on hard roads; lack of exercise leading to retarded circulation of blood in the feet; undue pressure on one foot from a painful condition in the opposite foot; circulatory disturbances coincident with parturition or indigestion.

The disease is ushered in with a chill. There is profuse sweating, rapid breathing, groaning from pain, loss of appetite, and a rise of temperature (103° to 104° F.). The feet are hot, very tender to taps with the hammer, and there is a distinct pulsation in their arteries. The animal exerts every effort to take the weight off the fore feet where the pain is intense. When standing the hind legs are placed well forward under the body to get as much relief as is possible. A foundered horse cannot be made to back; he even moves forward unwillingly.

The patient will be given great relief by cold-water applications to the feet. An easy way to apply moist cold is to saturate gunny sacks with water, or the animal may be made to stand in a foot-

bath. Give saltpeter in 2- to 4-ounce doses in the drinking-water three times daily, and if at all costive a quart of raw linseed oil. The grain ration should be materially cut down.

Chronic laminitis develops from the acute form. The coffin-bone rotates and presses on the upper surface of the sole, which in turn gives under the pressure and a "dropped sole" results. These changes lead to the formation of prominent rings and a concave instead of a straight toe wall. When standing the horse shifts his weight from one foot to the other; when traveling, the gait is stiff and the steps short and choppy. This peculiarity has led horsemen to believe that the soreness is in the chest, the pectoral muscles of which atrophy, and has given rise to the misnomer "chest founder."

Permanent relief cannot be expected from any line of treatment. However, by keeping the toe rasped down and applying a rubber heel pad or bar shoe a badly affected animal may be kept from getting severely lame, and should give good service on soft roads or ground. Hoof-packings and dressings to supply and conserve the moisture of the foot often afford material help.

SIDEBONE

A sidebone occurs when one of the lateral cartilages attached to the wing of the third phalanx or coffin-bone ossifies (Fig. 60). There are various causes of which a hereditary predisposition to lime-salt deposition in cartilaginous tissue appears to be the most common. Horses with flat feet and weak quarters are also predisposed to this disease. It is quite as certain that injuries from treads and similar wounds also set up an inflammation about these structures that may later result in sidebone formation. Lameness may or may not be present. In the later stages of the disease the only symptom is the hard, unelastic prominence just above the coronary band. It may be either unilateral or bilateral, and occur on any foot, but is more frequent in the front feet than the hind. In many cases only the lower portion of the cartilage undergoes ossification, the rest retaining its normal elasticity. Blistering or firing aggravates rather than remedies a sidebone. The most satisfactory treatment is to take the horse off city pavements and put him at work on soft ground. As a last resort, after other means have failed, unnerving may be attempted. Sidebones are properly classed with the unsoundnesses, although they do not interfere

with the serviceability of draft horses after lameness ceases. Unlike spavin and some other kinds of lameness, horses do not "warm out" of sidebone lameness.

TOE AND QUARTER CRACKS

Sand crack is another term for these diseases. They are splits in the horn of the wall, the position determining the exact name applicable. The causes are lack of moisture in the hoofs; heavy shoes; nailing the shoe too close to the quarters; separation of the horn from the pododerm. The crack first appears at the coronary band, from where it gradually extends downward either by growth or by splitting the horn. Lameness is caused if the fissure is deep. The first step in treatment consists in removing the shoe and softening the horn by poultices, or by standing in water for a few days. If the sensitive tissues at the coronet can be made to secrete horn of a resistant nature, the crack will disappear in time at the lower border of the wall. To aid in this, a piece of the bearing surface in contact with the shoe about 2 inches long should be cut away to prevent pressure. Shoeing with a bar-shoe is helpful. The edges of the crack may be drawn together with a nail. It takes about one year for a sand crack to grow down. The disease is an unsoundness.

CANKER

Canker results from infection of the pododerm or foot-skin. It is a disease with a slow course, during which a gradual undermining of the horn of the sole and frog takes place. Unless relief is given these structures eventually loosen. Treatment is purely local, and consists in providing dry quarters, removal of all involved tissues, applying antiseptics, and in protecting the exposed sensitive parts from external influences. Most cases of canker require several weeks and often months of careful treatment for a cure.

CONTRACTED HEELS

Contracted heels is a narrowing or "tied-in" condition most often seen in the front feet. Lack of exercise, too little moisture, thrush, or navicular disease may produce contraction. It is, therefore, a symptom of some other affection rather than a disease itself. Remedial measures are given in connection with these other diseases.

NAVICULAR DISEASE

Navicular disease is a chronic inflammation of one or more of the following structures: the navicular bone, the navicular joint, the navicular bursa, the perforans tendon. When the pathologic changes first start they are usually confined to the bone itself. There is a progressive rarefying ostitis that finally undermines the articular cartilage and results in erosion to its smooth surface. At this stage pain is pronounced with each and every movement of the joint. Many observations show that navicular disease occurs almost exclusively in harness horses. The exact cause is often impossible to locate. There seems to be a particular tendency for it to appear in animals subject to the so-called spavin group of lamenesses. Whether or not this is an inherited tendency remains to be definitely proved.

The *symptoms* are at first hardly noticeable. Quite without warning the horse may limp, but after a few steps recovers. When resting the foot is advanced or "pointed" and the toe is placed on the ground. The fetlock is flexed to take pressure off the navicular apparatus. Later intermittent lameness occurs. In more advanced cases of the disease the patient becomes severely lame for a week or more. This may continue or disappear, only to recur after weeks or even months. Finally, lameness is constantly present and is aggravated with use. The heels contract, the feet dry out, the frog atrophies, the toe of the shoe wears away more rapidly than normally as it strikes the ground first, the horse stumbles, particularly when going up hill, and the gait is stiff. One writer summarizes the symptoms as follows: "Unless the case is bad the horse 'points,' raises his heel, and rounds his fetlock joint when standing. He walks sound, but when trotted goes 'short,' 'daisy cuts,' and 'digs his toes into the ground.' "

From what has been said about the pathology of navicular disease it is clear that few cases recover. Mechanical means to relieve the animal and render him serviceable are the most sensible forms of treatment. A plane shoe, without a bar or toe-calk, is best. If lameness persists, neurotomy may be performed to destroy sensation in the foot.

SHOEING

Before perusing this section, the one on the structure and functions of the foot should be carefully reviewed, as the information

there given sets forth the principles upon which shoeing is based.

Shoeing must be considered a necessary evil, because it gives an artificial base of support and interferes more or less with the physiologic movements of the foot. When properly applied, iron or steel shoes afford protection and render the horse more serviceable for road work. The objects of shoeing are: (1) To protect the hoof from excessive wear. (2) To prevent slipping and falling during winter. (3) To correct faulty positions of limbs that horses may render good service and increase their speed. (4) To cure or improve diseased or defective hoofs and feet.

In shoeing it is best to follow a definite plan of procedure. This includes—(1) An examination of the horse at rest, and then in motion, to detect irregularities in the foot's axis, quality of horn, cracks, rings, length and wear of the old shoes, peculiarities in the gait, and the presence of lameness. (2) Removal of the old shoe by carefully lifting the clinches to prevent injury to the horn. (3) Preparation of the hoof for the shoe. (4) Selection and fitting of suitable shoes.

Horn grows constantly, so the hoof must needs be reduced in size or prepared for the shoe at each shoeing. The experienced shoer relies upon the judgment of his eye to determine the correct relationship between the length of toe and the height of the heel. At this time he places the horse on a perfectly level floor to see that the paring and rasping have left the foot "in balance," or level, and the bearing surface suitable for attachment of the shoe. All the wall, the white line, and $\frac{1}{8}$ inch of the sole must come in contact with the shoe, so that each part shall bear its proportionate share of the weight. The frog and bars are not trimmed except in rare cases.

When the toe is left too long the heels do not perform their share in supporting the weight and bend toward and press unduly upon the frog. If more horn is removed from one side than the other, the foot is thrown out of balance and more strain and concussion placed on the side having the highest wall. This results in damage to the sensitive structures on that side from overwork, while those on the opposite side atrophy from lack of use.

Young horses, and those kept under conditions whereby the feet are moistened at regular intervals, must be shod oftener than other animals because the horn of their feet grows faster. A four-year

old should usually have the shoes set every three weeks, while an aged horse may go four weeks or longer. When the shoes are left on too long corns may develop, or the nails work loose and injure the feet.

The **horseshoe** in common use is machine turned, so must be fitted to the foot before being nailed on. There are shoes for front and hind feet and for right and left feet. They should be no heavier than will suffice for about one month's wear. The fullering is the groove on the lower surface of the shoe. It aids to prevent slipping and has the nail holes punched in it. Clips are ear-like projections drawn up at the toe and quarters to more firmly attach the shoe to the foot and take the strain off the nails. Calkings are placed at the toe and heels. They are useful to prevent slipping. The heel calk is turned at a right angle to the bar of the shoe. Somtimes the outer calk is turned horizontal to the bar. Summer shoe calks are blunt. Winter calks are sharp. Four-calked shoes are used to bring about certain kinds of toe action. Never-slip calks are useful for horses driven on city streets. They are objectionable, for the reason that they may break off or cause serious calk wounds. Their advantages are the quickness and convenience of application and sharpening. If calks are turned at the heels only, the toe of the shoe must be left thicker than the branches to avoid disturbing the normal setting down of the foot as little as possible.

The **bar-shoe** is used extensively in the cities. It is especially adapted for heavy draft horses with brittle walls and heels that are weak, low, or contracted. The bar rests on the frog and thus affords frog pressure. For horses which habitually pull their shoes off, either by getting them caught or by stepping on them, this shoe is best. It should not be used if navicular disease is present. On the other hand, it is the most suitable for many other forms of disease of the feet.

The **snow-shoe** is one well beveled on the inner border of the ground surface to prevent snow-balling. It is especially useful when the snow is damp and packs easily.

A **shoe to prevent mud slinging** is made in a similar fashion. It is used on light harness horses which have a tendency to sling mud.

The **nail plate** is made of two pieces of sheet steel riveted to a C-shaped strip of tarred canvas. The latter is interposed between the hoof and the shoe, so that the metal comes in contact with the

hoof only at the heels. It is very effective to prevent nails from being picked up, and has the further advantage of cheapness.

The **leather pad** is useful for flat-footed horses and prevents bruising of the sole and evaporation of moisture. It is also serviceable in preventing the horse from picking up nails.

Rubber pads would be used more, especially in the cities, if they were less expensive. As a device to prevent slipping, nothing is so effective. No calks are needed if rubber pads are used, which does away with danger from calk wounds. They are the only device that satisfactorily prevents snow-balling and allows the horse to do full work on snow-covered pavements.

Horseshoe nails have one side of the shank flat, the other concave. The point is beveled so as to draw it in the direction of the outer or flat side where it enters the horn. It is, therefore, imperative that the nail be held with its flat surface toward the outside of the shoe. Nails should always enter the white line. They are driven deep enough so that their heads are flush with the ground surface of the shoe. There are a number of different sizes. Numbers six to nine are the ones commonly used, but longer nails than necessary should be avoided.

Shoeing for special gaits and to correct faulty gaits can be no more than mentioned in this brief section. It is possible to make a pacer trot by applying a special shoe. A horse that stumbles will be given relief with a roller-motion shoe; that is, one well rounded at the toe so as to cause the animal to break over quicker. Lameness from sore flexor tendons, as a result of undue exertion or knee-sprung conformation, may be successfully treated with the roller-motion shoe. Curby and spavined horses are shod with high heel calks. Weighting the shoe on the inside or outside branch is an artificial aid to straighten wide and narrow ways of going.

Overreaching is that condition where the fore shoe is struck by the toe of the hind foot before it is lifted to be taken forward. It is commonly called *forging*, from the sound like pounding a forge. At times the toe wall may be quite seriously bruised. In colts forging is often due to fatigue, and in all animals to shoeing with too long a toe which breaks the foot's axis backward and delays picking up the foot. A short body, with long legs set too far back in front and too far forward behind, is a faulty conformation especially conducive to forging.

To correct this defect, shoes are applied to increase and quicken the action in the fore limb and retard it behind. The front shoe is made with short heel calks which slant forward, and no toe calk. The hind shoe has two lateral toe calks or clips and is set back a little from the toe wall.

Interfering is a striking of the supporting leg by the opposite foot. The hair is rubbed off and in some cases a severe wound is produced. The causes of interfering are fatigue from unaccustomed or overwork; bad conformation, more especially the base-wide and toe-narrow standing position; faulty or neglected shoeing. Each case must be studied and treated on its merits. A shoe with a thick, heavy outer heel calk helps to correct the improper gait.

CHAPTER XVI

DISEASES OF THE BONES, JOINTS, AND TEETH

INFLAMMATION OF BONE

The different parts of a bone are so closely associated in nature that it is difficult to determine whether the periosteum, the bone substance proper, or the bone-marrow is involved in the inflammatory process. Although the principles of treatment are the same for each, it is advantageous to know exactly where the inflammation is located.

Periostitis is inflammation of the periosteum or tissue covering the bone. It is the result of irritation in some form. Pain is the chief symptom of inflammation shown by the animal, and is severe because there is little opportunity for the tissue to swell as do the softer structures of the body. Heat and swelling are almost or quite imperceptible for the same reason. Treatment should be given in the early stages to be of greatest benefit. Rest is the remedy of most importance. The application of cold-water bandages, changed every hour or two, is an easy method of obtaining moist heat which aids in hastening recovery.

Ostitis is inflammation of the bone substance. The causes are either mechanical or infectious irritants. Among the common mechanical causes are injuries from blows, kicks, and other traumatisms. Not infrequently a non-infectious ostitis is converted into the septic form by subsequent infection with micro-organisms. The chief symptom of ostitis is the appearance of a hard projection from the surface of the bone. Such a growth is called an exostosis. Exostoses may occur anywhere on the bone, but are most often seen in the region of joints where they cause lameness. They nicely illustrate nature's effort to repair the injured structures. One characteristic of exostoses is slowness of growth. It may require years for them to reach their full size. Sometimes they become reduced in size or entirely disappear, but, as a rule, after an exostosis once develops it will remain as a permanent blemish. When an exostosis occurs at a joint and progresses so far that the

bones of the articulation become firmly welded together, the joint is said to be ankylosed and a stiff, immovable articulation results. A dull, continuous pain is always present in ostitis. The most satisfactory treatment is the counterirritant either applied as a blister or the actual cautery.

Osteomyelitis is inflammation of the bone-marrow. It is a serious disease, but fortunately is relatively rare. Suffice it to say that infectious forms of osteomyelitis are usually incurable.

From a practical point of view there are three forms of inflammation of bone which deserve especial mention. They are bone spavin, ring-bone, and splints. Usually they all cause an exostosis to appear at the seat of the inflammation. Each reduces the value of the horse for both work and breeding purposes, but not in the same degree. When considered in order of importance they should be ranked as mentioned above, for spavin is a more serious disease than ring-bone, which, in its turn, incapacitates the horse to a much greater extent than does a splint.

BONE SPAVIN

Bone spavin is the term applied to the exostosis that occurs on the inner side and in front of the hock-joint (Fig. 59). There are three kinds or forms of spavin—viz., (1) high or "true spavin," which is the most serious; (2) low or "jack spavin," which does not interfere to such an extent with the joint; (3) occult or "blind spavin," which involves the joint surfaces, presents no enlargement, but is accompanied by marked lameness.

The *causes* of bone spavin are those things which excite the tissues to inflammation—for example, a hereditary tendency from the sire or dam; faulty conformation; mechanical injuries to the hock, either from blows or kicks or from too rapid and hard work on paved streets; excessive strain upon the hock-joint from improper shoeing.

Symptoms.—Lameness is the first symptom noticeable. The horse avoids moving the joint and develops a characteristic "spavined gait," in which a slight hitch is observed in the hip on the affected side and a decided dropping of the opposite hip. This is most pronounced when the horse first starts, and results from throwing the weight of his body upon the sound leg. When driven a short distance he "warms out" of the lameness. After he

stands for a time and cools off and is then driven again, the lameness becomes much aggravated. An exostosis makes its appearance at the seat of the inflammation. No indication of the severity

Fig. 59.— The left metatarsal and lower row of tarsal bones showing a massive bone spavin. Complete ankylosis has occurred between all the bones.

of the spavin can be had from the size of the enlargement, which may be out of all proportion to the lameness. The toe of the shoe of a spavined horse is worn away to an appreciable extent. When

standing he frequently rests the heels of the diseased leg on the wall of the opposite foot for relief.

To determine the presence and severity of a spavin the animal may be subjected to the spavin or hock test. This is made by flexing the joint for at least a minute by grasping the lower end of the cannon with the hand and closing as completely as possible the angle formed by the leg and cannon bones. Immediately the animal is made to trot briskly away from the examiner. If a spavin is forming, the horse will show the peculiar lameness described above.

Treatment.—In treating a bone spavin the object aimed at is to hasten nature's effort toward ankylosis or union of the diseased bones. This requires transforming the existing chronic inflammation into the acute form. To accomplish this end more blood must be brought to the part. The application of blisters or the firing-iron are the means used to bring it about. Point firing, or the introduction of a red-hot pointed firing-iron through the skin into the bone tissue, is resorted to if the blister fails. Rest is an important adjunct to the treatment and is necessary for complete ankylosis. The horse should be shod with a high-heeled shoe to take the strain off the front of the joint.

RING-BONE

Ring-bone, like bone spavin, results in an exostosis, but occurs in the region of the large and small pastern bones (Fig. 60). The bones of the fore limbs are more frequently affected than those of the hind. There are unilateral and bilateral, high and low, and articular and non-articular ring-bones, depending on their exact location and extent. The causes are most often mechanical and are similar to those of spavin. Long sloping, or short upright pasterns, predispose to ring-bone formation. Lameness is the most evident symptom. Later, a hard swelling develops, over which the skin is freely movable. The horse "points" when standing and shows a well-marked stiffness when moving.

Treatment will depend on the character of the ring-bone; generally it is the same as for spavin. Here, as in similar cases where the actual cautery is applied, it must be deferred until acute inflammation has subsided. By trimming colts' feet regularly, and shoeing older horses so as to straighten the foot's axis, many cases can be prevented. As a last resort neurotomy may be tried.

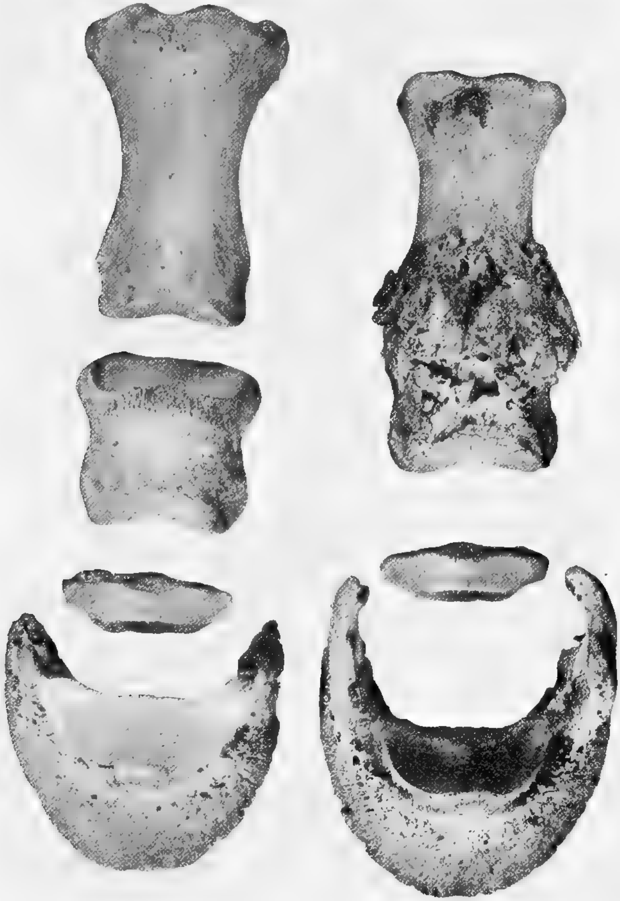

Fig. 60.—Normal and diseased digital bones. The fetlock joint was rendered immovable by the encroachment of the ring-bone. The lateral cartilages have ossified into side bones.

SPLINT

Splint is a form of exostosis appearing on the fore leg below the knee. It results in an ankylosis between the cannon and splint bones. It is found in about 70 per cent. of all adult horses; in 93

per cent. of these it is said to occur on the inner side. Fortunately the lameness resulting is very slight and transitory, or may not be noticeable at all. Splints may be either single or double. The so-called "pegged" split, a form in which the growth extends across the posterior surface of the metacarpus, is more serious and interferes with the play of the suspensory ligament. Splints causing no lameness are considered to be blemishes only and require no treatment. Others are treated according to the directions given for spavin and ring-bone.

OSTEOMALACIA

Osteomalacia is a disease of mature animals arising from general nutritional disturbances and causing an increased absorption of lime salts from the bones. In America several outbreaks have been observed among horses, especially in regions where soil conditions were unfavorable and in dry years.

Deficiency of available lime for the organism is the important causative factor. Forage grown on soil lacking in phosphoric acid and lime may contain less mineral substance than the animal needs. As an exclusive ration it would be unsuitable.

Digestive disturbances, a run-down condition, and hidebound appearance are the first symptoms noticeable. Later the animal develops anemia, a depraved appetite, and diarrhea. Lameness occurs, which is usually erroneously diagnosed as rheumatism. Swelling of the face, a symptom of osteoporosis or "big head," a disease closely allied to osteomalacia, is seen in advanced cases. The bones of the limbs are subject to enlargements and deformities from the deficiency in mineral matter.

Osteomalacia is a chronic disease and lasts for months or years. When treatment is instituted early good recoveries may be looked for. The affected animals should be removed to another region where soil conditions are better, or a change made in their feed. If phosphorus is lacking, bean, pea, or clover hays are beneficial, for they contain relatively large amounts of protein. Lime salts should be added to the diet as in rickets.

RICKETS

Rickets affects young animals only, and is due to a disturbance in metabolism. It is characterized by the persistence of the

cartilaginous tissue and the appearance of deformities in the skeleton.

Cause.—Like osteomalacia of older animals, it is caused by a deficiency in lime salts. This is substantiated by experimental and direct observations, and may be demonstrated in animals weaned too young and deprived of the normal supply of lime previously furnished by the mother's milk. Rickets more often occurs if the food is of such a nature as to cause digestive disturbances and interfere with absorption. The exact nature of the disease is still unsettled.

Symptoms.—In the first stages the young animal seems weak and loses his appetite; the belly becomes bloated, and often an obstinate diarrhea sets in. The most important symptom is a disturbance in locomotion, brought about by pains and aches in the bones. Affected animals step about restlessly, move stiffly and with care, lie down much of the time, and resent being disturbed. The bones of the limbs become enlarged at their ends, producing hard, sensitive swellings at the joints. If not arrested, rickets soon leads to softening of the bones. In extreme cases the bone tissue is so soft it can be cut with a knife.

Treatment.—If treatment is not given, rickets may run a chronic course of several months, but spontaneous recoveries are not infrequent. As soon as the diagnosis is made the diet should be regulated and good quarters and an opportunity for daily exercise provided. Food rich in calcium, especially green feed, is nature's remedy. In many cases lime in the form of powdered chalk (calcium carbonate) will be found beneficial. The daily dose for foals is 10 to 20 grams. Precipitated calcium phosphate should be administered if the food is deficient in phosphates.

BONE FRACTURES

A *fracture* is defined as a break in a bone. Kicks, blows, and falls on slippery pavements are common accidents that may result in fracture. A simple fracture results from a break into but two parts and the skin remains unbroken. This form is the least serious, for healing usually takes place without infection. If the skin is wounded and one of the broken ends protrudes it is termed a compound fracture. This is very serious, for the protruding end always becomes infected. A comminuted fracture is one where the

bone is broken into three or more pieces. Besides these, there may be recognized complete, incomplete, transverse, longitudinal, greenstick, double, and triple fractures.

The horse, according to records compiled from many cases, breaks the tibia eighteen times to the pelvis sixteen, first phalanx thirteen, and radius eight times. When the point of the hip is chipped or fractured the animal is said to be "hipped." It does not often cause lameness or diminish usefulness.

The first *symptom* of fracture is the inability to support weight, which causes the animal to go on three legs. Usually pain is evinced, although fractures of the pelvic and some other bones may be almost painless. When the fractured ends of the bone are displaced a swelling results. Other symptoms are abnormal mobility, or the appearance of an extra joint, and crepitation, or the characteristic grating sound caused by the rubbing together of the broken pieces of bone. Severe fractures greatly derange the general condition of the animal.

The *treatment* of a fracture is much more difficult in animals than in the human patient for they fight restraint. The fracture must first be reduced; that is, the ends of the broken bone replaced in the normal position. These ends must then be retained in position until "knitting" has been completed. It may be necessary to exert traction to get the ends in apposition.

Various schemes have been devised to hold the fractured bone in position. Metal or wood splints are most commonly employed. These are held by plaster-of-Paris bandages, which harden on exposure to the air into a firm cast. If no skin wound is present, a thin layer of cotton batting, held in place by a woolen bandage, is applied under the cast. Care should be used not to get the bandage too tight, as the circulation would be interfered with.

Slings are used to keep the patient in the standing position. A narrow stall is best, as it affords opportunity for support from leaning against the sides. Laxative, nutritious foods must be supplied with plenty of green fodder and mineral substances to aid nature in repairing the bone. Horses must be kept at least seven weeks in the slings, and should not be put to work for three months.

Complications of various kinds may follow fractures. Probably septicemia is the most common in cases where a compound fracture exists. Founder and tetanus are others. When the ends are not kept in contact during the healing process, one leg becomes

shorter than the other and a permanent lameness results, or a "false joint" forms.

The "knitting" of a fractured bone differs little from the healing of wounds of the skin. A jelly-like substance is poured out from the injured ends. By the action of certain cells this substance soon turns to gristle and forms a callus, or bony enlargement, which completely surrounds the fracture and firmly welds the ends together. Cells from the periosteum and bone-marrow play the most important rôle in uniting a fracture. The administration of small doses of phosphorus assists callus formation.

JOINT DISEASES

All joint diseases are accompanied with inflammatory changes. The term *arthritis* is used in a broad sense to denote any form of joint inflammation. Serous arthritis is the most common form of mature horses. In foals suppurative arthritis is more frequently seen, as it results from navel infection.

The most frequently occurring joint diseases are dislocations, sprains, deforming arthritis, and overfilling of the joint capsules with synovial fluid. Any freely movable joint may become affected. As the stifle, hock, and fetlock joints are most often the seats of these diseases, they will be taken as types for illustration.

Dislocation of the patella is displacement of this bone from the trochlea of the femur. It may be either partial and temporary or complete and permanent. The horse is said to be "stifled" when this accident occurs. Slipping when getting up in the stall, and stepping down from the stable floor to the ground some inches lower, are movements that may cause the patella to slip out of position. It may either snap back into place as soon as the joint is flexed, or catch and remain stationary at either the upper or outer side of the trochlea. In some cases it slips in and out with every step without preventing locomotion, but rendering the animal worthless, if long continued, by bringing about excessive wear on the articular cartilages. In upward dislocation the stifle joint is abnormally extended, which causes the leg to become rigidly stretched backward and makes progression almost impossible. Even with assistance the horse cannot bring the leg forward. By suddenly moving the animal backward and to the side the bone may slip back into position. If this is unsuccessful, place a rope around the pastern and lift the toe forward and upward; at the

same time lift the patella upward with both hands. An audible click will be heard when the bone slips back into place. After-

Fig. 61.—Diseased left stifle joint; sagittal section passing through inner ridge of trochlea of femur: 1, Thickened synovial membrane of joint capsule; 2, free joint bodies; 3, epiphyseal lines; 4, upper extension of femoropatellar joint cavity; 5, lower end of same.

treatment consists in the application of a stiff blister or the firing-iron to the stifle to strengthen the tissues.

Sprain of the fetlock joint results in momentary separation of the joint surfaces and overstretching of the joint capsule and ligaments. The causes are traumatisms, like fast work on rough ground and catching the foot between planks. When passively rotated pain is severe. Within a short time swelling, heat, and lameness are noticeable. Treatment consists in rest and moist heat. The application of a plaster-of-Paris bandage gives support and at the same time compression, both of which hasten recovery.

Deforming arthritis is seen in both young and old horses. Its presence is shown by a deforming enlargement of the affected joint. The causes may be infection through the navel while it is yet raw; rheumatism; traumatisms. Lameness of a transitory character that becomes gradually more persistent and permanent is the first symptom. There soon develops a sensitive swelling throughout the joint, and an effort is made to restrict joint movement as much as possible. This may shortly result in a peculiar gait even when walking. Figure 61 is a photograph of one of the author's cases.[1] It shows erosion of the articular cartilages, distention of the joint capsule, free joint bodies, and other degenerative and proliferative changes. The probability of effecting a cure in this class of joint troubles is very remote.

Bog spavin is a serous inflammation of the synovial layer of the capsule of the hock-joint. It is accompanied with the formation of an abnormal amount of synovia which causes the soft tissues around the joint to bulge outward. Horses of all ages are subject to bog spavin, but it is more common in loose-jointed draft colts. It rarely occasions lameness and may disappear without treatment. The well-defined, puffy swelling is soft and situated in front and to the inside of the hock (Fig. 62). Treatment should aim at the absorption of the accumulated fluid. This is best accomplished by applying a special bog-spavin truss, arranged so as to bring pressure over the swelling. Blisters afford but little relief in these cases. The fluid may be drawn off antiseptically with a capillary trocar or aspirating syringe, but the sac will fill again in a short time. Tincture of iodin, applied externally, helps to absorb the fluid. Old cases do not respond to treatment at all satisfactorily.

Thoroughpin is found associated with bog spavin. If the latter is not large, little or no evidence of a thoroughpin will be evident.

[1] American Journal of Veterinary Medicine, vol. viii, May, 1913.

When the tibiotarsal joint capsule is greatly distended with synovial fluid a well-marked soft swelling appears on the outside of the hock. By palpating the swelling the fluid can be felt to fluctuate if the other hand is placed over the center of the bog in front of the hock. As in bog spavin, the serous fluid may accumulate very rapidly—in some cases within twenty-four hours. Not often does it disappear spontaneously. Unfortunately, no reliable method of

Fig. 62.—Bog spavin.

treatment is known. The application of pressure and of massage has been followed by success in some cases, so should be tried before more heroic measures are attempted.

DISEASES AND DEFECTS OF THE TEETH

Most abnormalities in the teeth interfere with mastication. The symptoms usually caused by them are:

(1) Holding the head to one side and cautious masticating movements.

(2) Dropping food from the mouth, which is found in the manger in the form of balls.

(3) Retention of food in the mouth for some time after eating.

(4) Poor general condition and hidebound appearance.

When any one of these symptoms is observed the teeth should be carefully examined for evidences of dental disease.

Decay of the teeth starts when the enamel covering is broken and the dentine is exposed to the influence of the bacteria and acids

Fig. 63.—Shear- or scissor-formed mouth. This condition might have been prevented by early use of veterinary dental instruments.

in the mouth. It is a pathologic condition which advances very slowly on account of the great resistance exhibited by this part of the tooth. Eventually it leads to more or less complete destruction of the affected tooth. In man it is possible to fill teeth, but this is rarely done in animals. It is, therefore, impossible to save a tooth when once caries sets in. The only thing that can be done is to extract it and to shorten the tooth in the opposite arcade, as it is usually elongated and may seriously interfere with closure of the mouth.

Alveolar periostitis results when the alveolar cavity is opened

to infection. Normally the gums hermetically seal the alveolus from external influences. Treatment consists in early extraction.

A **tooth fistula** is an opening near the root of a tooth through which a continuous, foul-smelling, discharge of pus escapes. The diseased tooth must be completely removed before the fistula can be cured. It oftenest occurs in young horses and is commoner in the lower than the upper jaw.

Irregularities of wear in the teeth occur surprisingly often. They are due to unequal hardness of opposing teeth, or to congenital deformities, like a narrow upper or lower jaw. The first condition leads to the formation of sharp, enamel points that may injure the tongue or cheeks if not removed. Sometimes a wave-formed mouth results, or that closely allied irregularity, the step-formed mouth. Parrot-mouth, or receding jaw, and shear- or scissor-formed mouth (Fig. 63) are congenital anomalies in which the teeth of the two arcades do not wear on each other.

CHAPTER XVII

DIGESTIVE DISTURBANCES

CONSTIPATION

Constipation is a symptom of various diseases, but particularly of those primarily affecting the digestive organs. The fecal material is retained mostly in the large intestine.

Like most digestive disturbances, it is due to errors in feeding or watering. Other causes are constitutional weaknesses, mechanical obstructions, and lack of general exercise. Concentrated feed with little roughage, especially when given in excess, interferes with digestion and causes constipation.

Foals, in which this trouble is oftenest seen, strain, pass considerable gas (flatulence), and show recurring attacks of colicky pains. In them, as in older horses, the appetite is impaired. The absence of peristalsis is a certain symptom. Constipation rarely kills, but may lead to complications that endanger life.

Treatment.—Regulate the diet and drink to suit the needs of the animal. Fasting for a time and then providing food of a non-irritating, easily digested character is all that is necessary in cases of simple constipation. Rectal injections of warm water, in which a little soap has been dissolved, are very useful in mild cases of constipation, and may be easily given by the use of a rubber tube attached to a funnel. A pint and a half of raw linseed oil is a mild, gentle, and extremely valuable laxative and lubricant. If much bloating is present, add 2 ounces of turpentine to the oil. Too drastic purgatives may cause a rupture of the bowel. Do not expect immediate results from a physic given to relieve constipation. Herbivorous animals have a long, tortuous digestive canal and large masses of food materials must be moved.

IMPACTION

Impaction is closely related to constipation. It arises from feeding excessive amounts of foods rich in cellulose and wood fibers;

for example, such roughage as straw, chaff, corn-stalks, and very coarse hay. All the symptoms exhibited in constipation are present, but in a more marked degree. In addition, there may be observed dulness, abdominal pain, and straining as if to urinate. Masses of vegetable matter collect in large balls either in the cecum or colon, due to failure of the muscles in the walls of the bowel to act. This leads to intestinal obstruction. Soon the added weight, together with the distention produced by the gases, causes the bowel to overstretch. The result is interference with the normal movements. Putrefaction of the retained fecal material sets in and there are produced poisonous substances which are rapidly absorbed. There results a typical intestinal auto-intoxication. For these cases use 1 quart of raw linseed oil mixed with $\frac{1}{2}$ ounce of fluidextract of nux vomica as one dose. The oil acts as a lubricating agent, while the nux vomica adds tone to the muscular part of the intestinal walls and facilitates passage of the accumulated fecal material.

DIARRHEA

The term "diarrhea" is applied to the too fast passage of food and liquids through the bowels. Purging and scouring are other terms signifying the same condition. Loosely coupled horses, with lack of spring to their ribs, are subject to recurring attacks of diarrhea from trifling changes of food, water, temperature, or exercise. There is a common belief that horses of light sorrel, buckskin, or dun color are predisposed to the disease. Diarrhea is often brought on by working horses too soon after feeding. In such cases it may be prevented and controlled by allowing longer periods of rest after feeding. Greedy feeders are subject to diarrhea from bolting their food in an improperly masticated condition. A few stones the size of a goose egg placed in the feed box, or a feed of hay before the grain is given, will prevent this. Bad or irregular teeth, indigestion, unwholesome food, intestinal worms, and last, but not least, bacterial infection may cause diarrhea.

A diarrhea affords protection to the body by ridding it of great numbers of putrefactive bacteria and other irritating substances. When continued for any length of time it favors the maintenance of inflammation and does harm. It is usually advisable in controlling diarrhea to start with the administration of a physic. This clears the intestines of irritating material, and should be

followed in a few hours by a remedy to decrease peristaltic action. For this purpose nothing has been found more suitable than laudanum (opium) in 1-ounce doses at intervals of twenty-four hours.

INDIGESTION

Acute indigestion is really a form of colic. It is described in the next section. *Chronic indigestion* affects either the stomach or bowels or both of these organs. It occurs as a catarrhal inflammation of the mucous lining. When the liver fails to perform its work in disposing of the toxic products of digestion, or excessive gas formation occurs from the action of the bacterial flora on the ingesta, indigestion results. Both of these conditions are referable to errors in feeding, poor mastication of the food, or constitutional weakness.

The continued presence of gases leads to a stretching and tightening of the intestinal walls and interference with the normal circulation of blood. The result is a series of inflammatory changes which, if long continued, ends in causing adhesions between the intestine and the abdominal wall, or between different loops of the intestine itself.

The *symptoms* of chronic indigestion are loss in condition, depraved appetite, bloating, flatulence, mucous-coated feces. The skin is dry, lacks its usual gloss, and the animal becomes "hide-bound." Even the horn of the hoofs gets shelly and brittle from the general inanition.

Many times all the *treatment* necessary is the removal of the operating causes and a regulation of the diet. The condition of the teeth should be carefully examined and dental attention given if they require it. A digestive tonic, composed of Glauber's salts, 22 parts; baking soda, 18 parts; common salt, 9 parts, is good to stimulate the appetite and aid digestion. The dose is a tablespoonful on the feed twice daily. Fowler's solution of arsenic is one of the best tonics for horses affected with chronic indigestion. It may be given in ounce doses three times a day.

COLIC

Colic is the most frequent and fatal disease of horses. As ordinarily used, the term "colic" is very inclusive and refers to any condition in which the animal shows abdominal pain. Obviously, then, colic would include a great many painful conditions of organs

situated in the abdominal cavity other than the stomach and bowels. Our discussion will be limited to **true colic,** proceeding from the intestinal canal and stomach. **False colic** may arise from painful diseases of the bladder, kidney, and other abdominal organs except those comprising the digestive tube. It is thus readily seen that the symptom, abdominal pain, is not pathognomonic of colic. The absurdity of laying down a set of rules to follow in all cases is likewise apparent.

Causes.—General predisposing causes of colic are the relatively small size of the stomach and the complicated arrangement of the intestines. General determining causes include all forces which may induce acute indigestion, such as food, water, and errors in the proper distribution of work and rest. Of these the last are the most important. As they are largely under the control of the horseman, he usually has no one but himself to blame if his charge develops colic.

The two *symptoms* characteristic of and always present in true colic are pain originating in the stomach or bowels and suppressed or altered peristalsis. When these are found it is safe to diagnose the case as colic. All colics are dangerous and no time should be lost in rendering relief, as complications of a very serious nature are apt to set in at any time. Approximately, 10 per cent. of the cases end fatally.

Although veterinarians recognize no less than five varieties of colic, most cases may be classed either as a form of spasmodic or flatulent colic. After a little practical experience it is not difficult to differentiate between these two forms.

Spasmodic colic is a sudden and violent contraction of the muscular coat of the bowels. It is produced by such things as a large drink of cold water when warm, exposure to cold rains or draughts, a sudden change in the character of the feed. Some horses, from natural weakness of the digestive organs, are susceptible to colic and must be handled with especial care. This form of colic is oftenest seen in animals of a nervous temperament kept under good stable conditions.

The *symptoms*, as usually seen, are a sudden attack of pain, lasting from five to fifteen minutes, with a tendency to recur; turning of the head toward the flank; "chills" due to improper distribution of the blood; pawing and stamping with the feet; profuse sweating; attempts to lie down and roll, in severe pain the

horse may even violently throw himself; rapid breathing; intensification of the intestinal murmurs; assumption of an attitude like a dog on his haunches. At times the animal may strain as if trying to urinate, but this symptom must not be mistaken for a sign of "kidney trouble," which rarely occurs.

First-aid *treatment* consists in making the patient comfortable. All covering and harness must be immediately removed and the animal placed in a well-bedded box-stall, where he has plenty of room to roll without danger. A quieting medicine may now be given. For this purpose a mixture of 1 ounce each of sulphuric ether and laudanum in a cup of water has been found very satisfactory. A rectal injection with 6 or 8 quarts of warm, soapy water will be found beneficial to empty the rectum and induce the expulsion of gas. If the pain does not abate within a reasonable period, lose no time in calling a competent veterinarian, for it is probable that the horse is suffering from a complication. A safe colic mixture may be made by mixing 2 parts oil of peppermint, 15 parts oil of turpentine, 15 parts tincture of ginger, 15 parts ether, and 32 parts raw linseed oil. One pint may be given at a dose (repeat in an hour, if necessary).

Flatulent colic is also known by the names *wind, gaseous,* and *bloat colic.* It is characterized by the accumulation of excessive amounts of gas in the stomach and bowels. Fermenting foods, new hay or grass, a too rapidly eaten meal, either upon an empty or tired stomach, overeating on sound grain, or eating spoiled grain are all possible causes.

The *symptoms* resemble those of spasmodic colic with the following exceptions—the abdominal pain is not so severe, but is more constant; there is less violence shown by the patient in his attempts to get relief; a pronounced bloating occurs and the right flank often becomes very tense from distention with gas; tinkling sounds may be heard when the ear is placed over the flank, but peristalsis has ceased. As in spasmodic colic, both feed and water are refused.

Treatment should be stimulative rather than sedative. Administer agents to assist in toning up the system and hastening elimination of the irritating materials and gases from the stomach and intestines. The stomach-tube may be used to remove the stomach contents. When the cecum is much distended with gas and the patient is distressed, a mechanical opening must be provided

by plunging a small trocar through the wall of the right flank for escape of the gas. Veterinarians favor hypodermic injections of arecalin or physostigmin in moderate doses until relief is apparent. A good remedy is made by mixing 8 ounces aromatic spirits of ammonia with 2 ounces fluidextract of nux vomica. This mixture is given in 2-ounce doses diluted with ½ pint of cold water every two or three hours. The diet must be restricted for some days after the pain has disappeared.

INFLAMMATION OF THE BOWELS

Enteritis is another term for this disease, in which the mucous lining of the intestines becomes greatly congested and inflamed. It is acute, severe, and usually fatal. In practice it most frequently appears as a sequela of indigestion. Twists and folds of the intestines interfere with the circulation and cause intense inflammatory changes.

The *symptoms* are similar to those of colic, but are more pronounced in every way except the abdominal pain. The case is ushered in with severe chills and fever above 103° F., as a rule. The pulse is hard, fast, and wiry; the respirations are hurried and oppressed; the visible mucous membranes become deeply congested. When the horse lies down he does so very carefully. Pressure over the abdomen causes pain and will be resented. An anxious, distressed expression is noticeable, and the patient either paws continuously or walks around in his stall until exhausted.

Little can be done by way of *treatment* other than to mitigate the animal's sufferings. Ounce doses of laudanum in a quart of linseed tea will relieve the pain and act as a dressing to the inflamed lining of the intestines.

CHAPTER XVIII

DISEASES OF THE URINARY AND REPRODUCTIVE ORGANS

ABNORMAL URINE

Hematuria signifies the presence of blood in the urine. It results from severe inflammation of any portion of the urinary tract. Injuries to the bladder from bladder-stone is a common cause. When collected in a glass and allowed to stand the blood-corpuscles appear as a red sediment. In azoturia the urine takes on a dark-brown or coffee color from the presence of large quantities of free hemoglobin (hemoglobinuria).

Turbid urine is seen in health. The turbidity is due to the large amount of lime and magnesium salts in the urine. When the pelvis of the kidney or the bladder becomes infected with pus-producing organisms the turbidity of the urine is increased. A viscid, gelatinous sediment occurs in these cases due to the presence of a large amount of mucin.

Polyuria signifies the habitual excessive discharge of urine. It is a symptom of diabetes, and is due to overstimulation of the kidneys from improper feeds or to reckless administration of diuretic medicines. The patient shows great thirst, a depraved appetite, and a rough coat.

Frequent urination is a very disagreeable vice, confined mostly to mares. They will stop at frequent intervals to pass small quantities of urine. It may be caused by irritation from a stone in the bladder or by nervousness coincident with the period of heat.

RETENTION OF THE URINE

Inability to pass urine often complicates azoturia, colic, and other diseases. It is due to a paralysis of the muscles in the bladder walls or to a spasm of the muscle which guards the opening into the urethra. In the male strictures in the urethra, an accumulation of smegma in the sheath, and other mechanical obstructions

may close the opening of the penis so as to interfere with the escape of urine. The important symptom is inability to urinate even when frequent efforts are made to do so. If standing, the animal stretches out and violently strains, but either can pass no urine at all or only a few drops. The pain caused by the distention of the bladder walls is evidenced by groaning. By palpation through the walls of the rectum the greatly distended bladder can be felt. In the mare pressure upon it causes the urine to flow out in a stream. The bladder of the stallion or gelding can be emptied only by use of the catheter. Where tumors or other mechanical objects press upon the urethra the only permanent relief is to completely remove the obstructions. If the sheath is foul from an accumulation of dirt and smegma, it should be carefully washed with warm water and castile soap and then greased with vaselin.

INFLAMMATION OF THE KIDNEYS

Nephritis is a rare disease in the horse. The reason for mentioning it in this work is to emphasize the fact that many times errors are made in diagnosis, and diseases originating or located elsewhere are referred to the kidneys. Soreness in the muscles of the loin from overexertion or exposure to cold is commonly diagnosed as nephritis, because the animal exhibits tenderness when pinched. If the temperature is elevated, the urine abnormal in quantity or quality, and the legs swollen, there is a greater certainty that the kidneys are inflamed. In this event they should be relieved from work by eliminating waste products through the alimentary tract and skin.

STERILITY AND BARRENNESS

Sterility is the term used to denote the inability of the stallion to procreate or beget. We can no more than mention some of the possible causes. These are congenital defects and malformations, the commonest of which is cryptorchidy, when both testicles are retained within the abdominal cavity; infestation of the testicle with round-worms, which in one case observed by us resulted in enlargement of the organ to ten times the normal size; acquired affections caused by tumors, injuries, constitutional and infectious diseases; idleness resulting in excessive fatness; masturbation, and finally overwork in the stud.

A distinction should be made between temporary sterility and permanent sterility. The first is amenable to remedial treatment, while the latter renders the stallion worthless as a sire. A microscopic examination of the semen will show whether the sperm cells are active and capable of progressing toward the ovum, which is usually fertilized in the fallopian tube.

Prevention is of great importance in handling cases of sterility. Proper feed, exercise, and care in arranging the number and times of service will do much toward eliminating sterility, besides the stallion begets better foals and retains his prepotency for a longer period.

Barrenness is the term properly applied to sterility in the mare. The causes are even more numerous than in the case of the male animal. The ovaries are frequently at fault. They may have failed to develop their function, and no ova, or only immature ones, are produced; cystic tumors and inflammation changes from any cause may be present and interfere with their normal activities. Advanced age, overfatness from close confinement and lack of exercise, or poor condition may so alter the sexual organs that the animal does not come in heat and will show no desire to mate. Infection following parturition and injuries received when the mare foals must also be considered when looking for the exact cause of barrenness.

The treatment for barrenness is precluded in this discussion on account of the great variety of causes, for each of which there must be prescribed treatment to meet the special condition. Artificial insemination (*q. v.*) has been used with success in cases where it was impossible to locate a particular cause.

It is commonly believed that certain drugs to stimulate sexual activity aid in remedying these diseases. Experience has failed to substantiate this belief. However, we do know that good feed and plenty of exercise are stimulants that have no equal.

In those cases where the mare is in heat almost continuously (nymphomania), but fails to conceive even after repeated service, relief may be had by spaying her, or the simpler operation of removing the clitoris.

DIFFICULT PARTURITION

Dystocia is the technical term for difficult labor. It may be due either to some defect on the part of the mother, as a deformity

or disease of the pelvic organs, or to some abnormality in the size, form, or position of the fetus. All that may be required is the straightening of a retained leg, or the turning of the head, to place the fetus in position so that the mare can proceed with the act of parturition. Unfortunately, in practice the difficulties are often much more serious and can be overcome only by resort to all the skill and resourcefulness possessed by an experienced veterinary obstetrist. Therefore, no time should be lost in calling him, and this before traction is exerted on the foal, for the chances of a successful delivery become rapidly less if assistance is delayed until the water-bags are ruptured and their contents escape and the mare is exhausted from continued straining.

DISTURBANCES FOLLOWING PARTURITION

Acute metritis means inflammation of the uterus. It results from the decomposition of bloody fluid and remnants of the afterbirth retained in the womb after parturition. Bacteria multiply very rapidly in this material under the warm, moist conditions that prevail. The poisonous products of their activity are quickly absorbed and blood-poisoning (toxemia) with its attendant symptoms sets in. This is shown by a fever ranging between 103° and 105° F., loss of appetite, shrinking of the udder, reduction in the milk flow of the mare, and digestive disturbances in the foal.

Unless the accumulated fluids and placental fragments are soon removed the symptoms become more aggravated and acute laminitis develops. Copious irrigations with warm 0.5 per cent. carbolic acid or other suitable antiseptic solution will serve as a means to cleanse the uterus. Care should be taken that all the fluid is removed, for the uterine walls are incapable of much contraction. In our experience simply swabbing out with sterile absorbent cotton moistened with tincture of iodin has given remarkably quick relief.

Retained placenta occurs less frequently in the mare than the cow. It is often caused by infection carried into the uterus at the time of parturition. Sometimes no cause can be found and the foal is born in a perfectly normal manner. In any event no time should be lost in removing the placenta, for it will decompose very rapidly. Toxemia results if the products of decomposition are absorbed. By gently pulling on the protruding membranes they may frequently be removed without inserting the hand. Frag-

ments of tissue and fluids must be flushed out with 0.5 per cent. solution of carbolic acid and the precautions mentioned above observed.

Inversion, or **prolapse of the uterus,** is an accident that may follow parturition. The uterus "turns wrong side out" and protrudes from the vagina as a pear-shaped, dark-red mass. When the severe straining incident to expulsion of the fetus is continued after the foal is born there is a decided probability that the uterus will prolapse. To replace properly the organ in its normal position requires the skill of an expert veterinarian. Great care must be taken to cleanse the exposed mucous surface of all dirt and filth. Stimulants to support the mare and medicines to ward off wound-infection diseases must also be administered.

CHAPTER XIX

PARASITES AND PARASITIC DISEASES

GENERAL CONSIDERATIONS

Parasites are living organisms which obtain their sustenance in whole or in part at the expense of other living organisms. More or less damage is always done the host by their presence.

In keeping with their location we are able to recognize external or ectoparasites and internal or entoparasites. All forms may be placed in one or another of the following divisions—permanent parasites, which spend their entire life with one host; temporary parasites, which spend but a part of their existence with one host; facultative parasites, which have the power to change from one host to another of a different species; obligatory parasites, which can live only on or in one species of animal.

The **effects of parasitism** depend on the number and position of the invaders. Injury is caused by the parasites from irritation; from drain by feeding upon the tissues and juices; from the absorption of poisons produced by the parasites; from their wanderings in the body tissues, and from obstruction of the natural passages.

All animal parasites of the horse belong to some one of the three following sections of the animal kingdom—protozoa, worms, or arthropodes.

Protozoa are the very lowest form of animal life. They are microscopic in size and possess the simplest form of digestive and respiratory apparatuses.

Worms have soft contractile bodies. They comprise a great number of parasites which find their habitat in the digestive, respiratory, circulatory, and other body organs.

Arthropoda are provided with jointed legs. The subdivisions of this group are (1) the *arachnida,* represented by the mange mites; (2) the *insecta,* common examples of which are the parasitic lice and flies.

PROTOZOAN DISEASES

Trypanosomiasis is the term used for those diseases caused by infestation with the Trypanosomes. There are several varieties of these protozoan parasites. They are found free in the blood-plasma and cause fever, loss of flesh, and progressive general anemia. *Dourine* is a typical protozoan disease. It is transmitted by sexual intercourse, so is described with the communicable diseases in Chapter XXI. *Surra* affects horses and other animals in tropical countries. The Trypanosoma evansi causes surra. Flies are known to be the carriers of the surra parasite.

WORMS

Round-worms are easily identified by the shape of their bodies and the complete digestive apparatus with which they are always provided. A number of different species are found inhabiting organs of the digestive, respiratory, and circulatory systems. Some are so minute as to be almost invisible to the naked eye, while others attain a length of 12 inches or more when fully developed. They cause damage by interfering with the functions of the infested organs. The effects are unthriftiness, emaciation, diarrhea, anemia, and even death. Among the most common forms infesting the horse are the Sclerostoma tetracanthum (blood-sucking worm), Sclerostoma equinum (palisade worm), Oxyuris curvula (pin-worm), and Ascaris megalocephala.

The *Ascaris megalocephala* is the large white worm so frequently seen in the feces. The male of this variety measures from 6 to 10 inches long, while the female may exceed 14 inches in length. They produce digestive disturbances, and may even mechanically clog the intestines if present in large numbers. A diagnosis is made by finding one of the adults or its eggs. A successful remedy to rid animals of these and other worms of the intestinal canal is 1 quart of raw linseed oil mixed with 2 or 3 ounces of oil of turpentine. This mixture is to be given in one dose on an empty stomach.

Tapeworms have flat, ribbon-shaped, segmented bodies and sucker disks by which they attach to the lining of the intestine. These parasites are only rarely met with. Instead of a digestive apparatus, tapeworms are provided with minute openings in the cuticle through which nourishment is absorbed. Each segment is capable of self-fertilization, for it is a hermaphrodite, possessing both male and female genital organs.

MANGE

Mange is a very contagious disease of the skin caused by infestation with a mange mite. Mites belong to the arachnida, and are so minute that they are just visible to the naked eye. They possess but four pairs of legs. There are three genera of mange mites recognized as infesting the horse—viz., Sarcoptes, Psoroptes, and Symbiotes. Of these, the Sarcoptes scabiei var. equi is the most destructive (Fig. 64). It burrows tunnels or galleries into the skin.

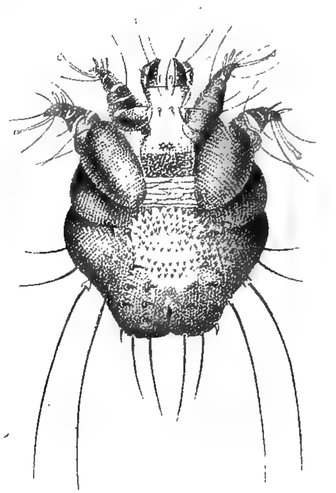

Fig. 64.—Sarcoptes scabiei, var. equi, or mange mite. This mite burrows into the deep layers of the skin. (U. S. Department of Agriculture.)

The symptoms of mange are intense itching, continuous rubbing, and the formation of scabs along the back and withers, where the parasites lodge just beyond the reach of the mouth and tail of the host. The irritation seems to be most marked during hot nights. The hair drops out and the skin thickens, cracks, and assumes a dead appearance.

To positively diagnose mange, scrapings should be made from the skin and examined under a microscope. By placing the scabs on a warm, black background a strong hand lens is sufficient to demonstrate their presence, but not their genera.

To destroy mange mites it is necessary to scrub the infested parts of the body with a warm coal-tar dip solution, or decoction made by boiling $1\frac{1}{2}$ pounds of tobacco leaves in 8 quarts of water. The harness, currycombs, brushes, and other stable paraphernalia should also be thoroughly saturated with the solution to kill any mites which may have crawled onto them. Treatment ought to be repeated in a week or ten days, to destroy such young mites as may have hatched from eggs in the meantime, for the latter resist the action of these parasiticides. It takes persistent work effectively to eradicate mange.

LICE

Lice are small, wingless insects. The females lay oval eggs, called "nits," and secrete a glue-like substance that attaches the

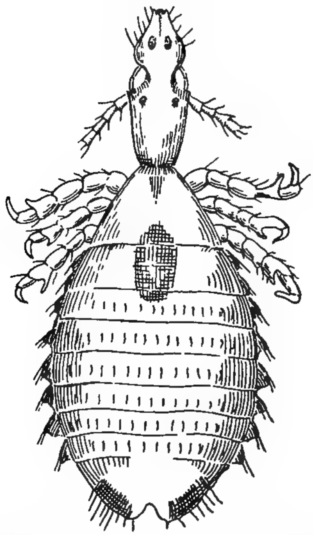

Fig. 65.—Hematopinus macrocephalus or louse. This is the common horse-louse, greatly enlarged.

eggs to the hair. After a varying period the young and complete insect raises the operculum from the large end of the egg, opposite to the point of attachment, and crawls out. In a short time it develops into an adult louse and is capable of reproduction.

The horse is commonly infested with one of two species of lice, but rarely with both at the same time. The Hematopinus macrocephalus is characterized by a long, narrow head and large, oval abdomen (Fig. 65). It measures slightly more than $\frac{1}{16}$ inch long, and obtains its living by biting and sucking the blood from its host. The Tricodectes pilosus has a head that is rounded in front and is broader than it is long. This louse lives principally on the epidermal scales. It is about half the size of the former.

To eradicate lice with dispatch, the horse must be clipped and then carefully singed. Thorough daily currying and rubbing with a rag moistened with kerosene is a means of getting rid of great numbers of adults and nits. A decoction of stavesacre seeds, made by boiling 4 ounces of the powdered seeds in a gallon of water, is recommended as a wash.

BOTS

Bots are the larva of the Gastrophilus equi or bot-fly (Figs. 66, 67). The female is woolly and gray brown in color. It hovers around the legs and neck, where it deposits eggs and cements them

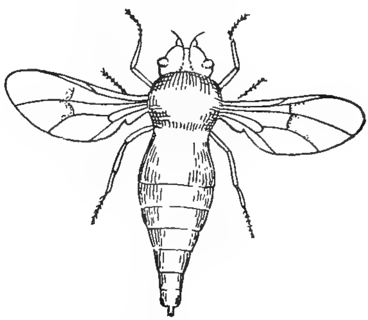

Fig. 66.—Gastrophilus equi or bot-fly. An adult female magnified about three diameters.

with a special secretion to the hair. These flies are most active in the hot summer months. After a time the eggs hatch and the minute larva irritate the skin, causing the host to bite the infested part. In this way they gain entrance to the mouth, and eventually to the stomach. Once here they attach themselves to the mucous lining and rapidly develop into the full-grown bot. Most

horses harbor a few, some as many as two or three hundred (Fig. 67).

The bots remain in the stomach for about ten months, or until May or June, sucking blood for their sustenance. Then they loosen their hold, pass along through the bowels with the ingesta, and escape in the feces. If conditions are favorable they burrow into the soil and form a pupa. Some four or six weeks are passed in this stage, after which a perfect fly emerges ready to lay eggs.

Many different remedies have been used to free horses from bots, but all are of little or no value. Drugs strong enough to

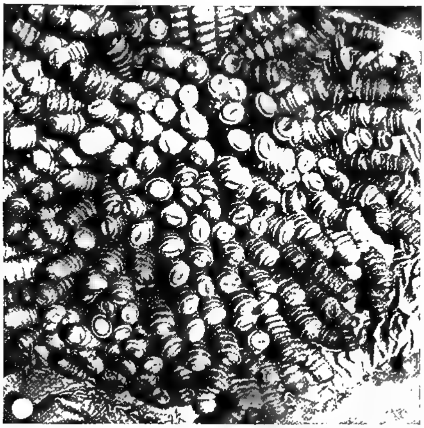

Fig. 67.—Bots attached to the lining of the stomach. Full-grown larva of the Gastrophilus equi. (U. S. Dept. of Agric., Division of Entomology.)

cause the bots to loosen their hold will injure the walls of the stomach, so cannot be used. Bots seldom cause serious injury, but may produce irritation and lack of thriftiness if present in large numbers by interfering with gastric secretion. In view of the fact that bots and many other internal parasites pass from the host as soon as the animals are turned out in the spring, treatment should be given in early winter to be effective. Prevention is easiest and most satisfactory. Clip off all eggs found attached to the hair with a sharp razor or destroy them by singeing with a flame.

CHAPTER XX

NON-COMMUNICABLE DISEASES

Non-communicable diseases include all affections that are not transmissible by direct or indirect contact from one animal to another. In general they are traceable to a disordered condition of metabolism which results in physiologic disturbances. Those that are due to digestive disorders have been discussed in Chapter XVI. In this chapter will be described the more common ones that result from mechanical interference with physiologic processes—*e. g.*, pneumonia and heaves, and those that arise from the production of substances which act as poisons to and interfere chemically with normal metabolism—*e. g.*, azoturia and forage-poisoning.

The course of this class of diseases varies widely and their symptoms are indefinite. As they often resemble certain communicable diseases in their more general manifestations, it may be difficult to make a differential diagnosis.

PNEUMONIA

Pneumonia means any inflammation of the lungs. It is accompanied by an exudation of liquid into the minute air-sacs, and later solid matter forms. This reduces the capacity of the lungs to deliver oxygen to the blood and remove carbon dioxid and the animal shows difficulty in breathing.

With our present knowledge it is impossible to attribute pneumonia of the horse to a specific micro-organism, although it seems probable that most cases, if not directly due to the presence of micro-organisms, are sooner or later infected with them. Direct irritation from foreign bodies like lung-worms, smoke, dust, drenching through the nose, and aspiration of food are exciting causes. Exposure to cold is known to play an important part in causing pneumonia.

At the outset the *symptoms* are not marked, and are either completely overlooked by the attendant or not regarded as indic-

ative of the disease. Too often the animal is kept at work until the respirations are rapid, the appetite lost, a deep cough develops, and the temperature rises to 104° or 105° F. After pneumonia is well advanced, the horse stands with the fore legs apart, the nostrils dilated to permit easier breathing, and the nose held so as to get the freshest air. Usually a rusty-colored nasal discharge is seen. Percussion and auscultation of the lungs reveal characteristic sounds that clinch the diagnosis in doubtful cases.

Pneumonia runs a rapid course; the temperature falls abruptly between the seventh and eleventh days in cases that are destined to terminate favorably. The prognosis must be guarded, for death frequently occurs from the effects of secondary invading organisms.

Treatment.—Good nursing and attention to hygienic and dietetic details are more important than drugs. A plentiful supply of pure air, comfortable quarters, special diet, and careful grooming, with bandages for the legs, are the chief reliance of the veterinary practitioner to-day. Stimulants like alcohol and aromatic spirits of ammonia are indicated for debilitated subjects after the temperature begins to fall and during convalescence. On account of the danger from drenching fluids into horses suffering from pneumonia, it is better to administer medicine in the form of a paste which can be smeared on the tongue or teeth. In uncomplicated cases drugs may be dispensed with entirely. Avoid putting the patient to work too soon, as overexertion is almost certain to result in a relapse.

PLEURISY

Pleuritis is inflammation of the pleura, the serous covering of the lungs. The inflammatory changes either induce an effusion of serous fluid into the pleural cavity or so roughen the smooth contact surfaces of the pleura that friction is produced with each respiration. It is due less frequently to a primary affection than to a secondary infection following puncture wounds of the thorax, or from pneumonia, glanders, and other infectious diseases.

Symptoms.—If the case is seen early, pain and chills are the noticeable symptoms. The temperature ranges from 105° to 106° F. and the pulse is quickened. Breathing is altered, in that an effort is made to restrict movement of the chest wall. This results in additional work for the abdominal muscles and the typical

"pleuritic ridge," extending from the lower ends of the false ribs to the external angle of the ilium, is seen with each respiratory movement.

Generally speaking, the course of pleurisy is slow. Recovery is not always complete, for adhesions occur between the pleura covering the lungs and that lining the walls of the thorax. This results in permanent interference with the normal expansion and contraction of these organs.

Treatment is similar to that mentioned for pneumonia. If pain is so great as to cause distress in breathing, ½ ounce of chloral hydrate may be given.

HEAVES

Heaves is a chronic, non-infectious condition of difficult breathing in which the act of expiration is longer than the inspiratory act. Heaves is not accompanied by fever and is not directly fatal. The chief pathologic change is confined to the lungs, the thin, delicate air-sacs of which break down and lose their normal contractile power.

Bulky foods, indigestible foods, and foods which ferment easily all lead to overdistention of the stomach and to excessive pressure upon the diaphragm. Dusty fodder, especially hay which has been wet during harvest, or over-ripe hay, is harmful and may induce heaves.

Symptoms.—A peculiar, dry, droning cough is heard before the difficult breathing, later so characteristic, is noticeable. The cough is explosive in nature and soon becomes very marked; furthermore, it is aggravated by dust and is accompanied by flatulence. Inhalation is normal, but exhalation is labored and difficult. This requires the patient to make a special effort to force out the air. As a result, there occurs a "double-pumping action" of the flanks with two expulsive efforts instead of one. This produces the so-called "heave-line" seen along the flanks of affected horses. With exercise these symptoms are much intensified. Disguised cases can be detected, or tests can be carried out by feeding all the dusty hay the horse will eat, then giving plenty of water and driving him briskly.

Treatment.—After the disease is once developed it is impossible to effect a cure for anatomic structures have been destroyed, so treatment can only be palliative. It is said that horses suffering

from heaves when taken to an arid country, where the disease is unknown in native horses, become serviceable and seldom are troubled thereafter. By reducing the roughage to a minimum and increasing the concentrates accordingly it is possible to make a badly affected animal serviceable.

To relieve heaves nothing has been found so beneficial as arsenic. It is used in the form of Fowler's solution. The remedy may be given in 1-ounce doses three times a day. When combined with the daily administration of Carlsbad salts, and continued over a long period, this treatment affords remarkable relief.

ROARING

Roaring is a disease of the air-passages in which a noise resembling a whistle or roar is produced at each forced inspiration, *i. e.*, following a brisk trot or heavy work. The fact that it is hereditary has led to the disqualification of afflicted stallions for public service in many states. In the usual form there is found a paralysis and wasting away of one of the groups of muscles which move a part of the larynx. Little hope can be entertained for spontaneous recovery. Within recent years an operation has been perfected which relieves about 70 per cent. of the horses operated upon when it is properly performed.

LYMPHANGITIS

"Monday morning disease" and **"big leg"** are other names for this disease. It is characterized by a suddenly appearing pronounced swelling and lameness in one hind leg. The lymphatics appear to be the structures affected.

There is some difference in opinion as to the *cause*. When an abrasion can be found in the skin through which infection has had an opportunity to enter, it is reasonable to attribute the disease to bacterial invasion. At other times unwonted idleness on full feed seems to be the determining cause. Heavy horses are predisposed to lymphangitis.

Symptoms.—The swelling progresses rapidly and soon extends around the leg. Pain is present and shown by the patient holding the leg in a position to get most relief. When the inguinal lymph-glands are palpated great sensitiveness is exhibited. Pressure with the finger-tips leaves well-marked pits. Fever as high as 105° or 106° F., with its usual accompaniments, is present.

Treatment consists in administering a purgative. Bathe the leg for half-hour periods three times each twenty-four hours with warm water, rub dry, and apply soap liniment with friction to stimulate circulation. Internally, give ounce doses of saltpeter three times a day. Regulate the diet by providing laxative feeds. When these directions are closely followed recovery is rapid, but recurrent attacks are apt to occur and lead to a permanent enlargement—"elephant leg."

AZOTURIA

Azoturia occurs when a horse accustomed to daily work is exercised after one or two idle days on full feed. It is characterized by a coffee-colored urine and a partial or complete paralysis of the hind legs. It may occur at any time of year, but it is more commonly seen in cold weather.

Azoturia is an auto-intoxication resulting from improper feeding and lack of exercise. Horses in good condition are most susceptible to it. It may be prevented with the greatest certainty by reducing the grain ration about one-third when the animal is idle.

Symptoms.—The horse starts away from the stable in particularly good spirits. Suddenly he lags, sweats profusely, and gets lame in one or both hind legs, which knuckle over at the ankles. Soon he is unable to stand and may fall, in which event he attempts to rise, but is only partially successful. Once down he rapidly becomes worse, and the symptoms are aggravated. The urine is retained and of a thick, dark, red-brown, or coffee color, and full of suspended matter. This color is due to hemoglobin from the disintegrated red blood-corpuscles. Its presence in the urine has given the disease the name *hemoglobinuria.* The muscles of the loins and thighs are swollen and very hard. The lining membrane of the eyelids is congested; the nostrils are dilated; the pulse at first full and bounding later becomes weak and fast. The appetite often remains good and the horse eats hay at every opportunity, while thirst may be extreme.

From 20 to 40 per cent. of the cases die, or their usefulness is more or less permanently impaired from atrophy of the affected muscles. Chances of recovery are poor if the patient is unable to move the limbs after a few days.

Treatment.—Just as soon as any of the above-mentioned symptoms are noticed the horse should be stopped. Driving even a short distance further is likely to result in more serious trouble and

lead to paralysis. Prompt rest is essential to recovery. The harness should be removed and the patient made comfortable with a blanket. It is not wise to try at once to lead him even to the nearest barn. The urine must be drawn off with a catheter at least twice a day, for the bladder is also paralyzed and cannot be emptied without help. Many different drugs have been employed, but none has proved a specific. The attending veterinarian should be relied upon to administer the treatment which, in his judgment, appears to be best. A gentle physic, together with iodid of potash in 1-dram doses three times a day, are all the drugs usually necessary in mild attacks. Good nursing and a soft bed to prevent injury while the patient is down are of more importance than medicines.

CEREBROSPINAL MENINGITIS

"Forage poisoning," "corn-stalk disease," and **"blind staggers"** are terms employed in different sections of the country for a disease that makes its presence known by materially altering the functions of the brain and the spinal cord.

Cause.—Poisonous substances in the food appear to be the cause of this disease. It is believed that various molds and fungi are the exact cause, but nobody has yet succeeded in producing it by feeding them to experimental animals. The theory has been advanced that an infectious agent is the cause. If this is a fact it must differ from most diseases of a similar nature, for the infection is not directly communicable from animal to animal.

Symptoms.—Affected horses either show great mental excitement or stupor, depending on the action of the bacterial toxins on the nervous tissue. The animal may be found delirious, and rushes about in the stall or paws and kicks, and in other ways seems blind to his surroundings. In many instances the primary symptoms are a staggering gait, a sleepy attitude, and dizziness. Later the patient falls to the floor, struggles to rise, but is unable to do so, and finally becomes unconscious and dies in two or three days.

Treatment is of little avail once the disease is well established. Medicines to quiet the animal and eliminate the toxic substances by way of the alimentary canal are indicated. For the latter subcutaneous administration of arecalin is highly recommended. Prophylactic treatment by changing the feed at once is said to prevent other animals on the farm from becoming affected. One attack of the disease does not confer immunity.

HEATSTROKE AND SUNSTROKE

Heatstroke and **sunstroke** are closely related. They result from overheating, combined with disturbances in the heat dissipation center. In their most typical form they occur while at work in the sun. Then there is more heat produced internally than when at rest, and the atmospheric temperature is somewhat above that of the body. After the sweat-glands have become fatigued from excessive activity, so that they no longer function properly, there is a greater probability of these diseases occurring.

The *symptoms* are a quick, hard pulse, cutaneous circulation at low ebb, congestion of the blood in the lungs, and dizziness. The temperature may be 110° F. or higher.

Treatment.—When a horse is overcome by heat get him into a shady place, wash out his mouth and nostrils, sponge his body, and shower his legs with cold water. Assistance must be prompt or it will be useless. Ice-packs are applied to cool the head. Two ounces of aromatic spirits of ammonia, or 2 ounces of sweet spirits of niter in a pint of water, is an effective stimulant to assist the heart action.

PERIODIC OPHTHALMIA

Moon-blindness, by which the above disease is commonly known, is characterized by periodically occurring attacks of inflammation of the eye. It usually results in the destruction of sight.

The exact cause is not known, but it is not difficult to prove that the disease is hereditary. However, it cannot be transmitted after birth. Affected stallions are disqualified by law in many countries for public service.

The first attacks are shorter in duration than later ones. An interval of several weeks intervenes between each two attacks. A diffuse inflammation of all parts of the eye occurs, with a profuse flow of tears, swollen lids, and great sensitiveness to light. With each succeeding attack the normally transparent structures become gradually clouded and opaque until permanent blindness results. In old cases the eyeball atrophies and recedes into its socket. This causes the upper lid to buckle near the center and what appears to be a third canthus forms.

Place the animal in a darkened stall at once. Bathe the eye with a warm saturated solution of boracic acid for twenty minutes

three times daily. Once the lens of the eye loses its transparency nothing can be done to restore the sight.

POISONING

Poisoning is rare except from accidental causes, and then almost always occurs from the ingestion of poisonous plants. Malicious poisoning is usually attempted with either arsenic or strychnin. When poisoning is suspected all other possible causes should be looked for, as in many cases a careful search will show that something else is actually responsible for the sickness.

To diagnose a fatal case accurately requires a careful postmortem examination and a chemical analysis of the stomach contents. The latter is quite expensive. When a poison is actually found in the food there is no longer any doubt about the cause of death.

Loco-weed poisoning is due to eating freely of two leguminous plants, Astragalus mollissimus and Aragallus lambertii. These plants grow in all our Western States, from sea level to the summits of the highest mountains. The poisonous principle is not known. Animals do not at first readily eat the weed or do so only when food becomes scarce. A taste is soon formed for it, so that addicted animals will leave good food and go without water to search for loco-weeds.

The most prominent symptom of locoism is a staggering and uncertain gait, caused by derangement of the nervous system. Horses shy and jump at imaginary objects. The animals gradually lose flesh and sooner or later die of starvation. Death occurs in a comparatively short time in some cases.

There is no specific antidote known for loco-poisoning. Remedies to relieve constipation and Fowler's solution of arsenic in $\frac{1}{2}$-ounce doses once each day have given the best results experimentally. Most locoed animals with the above treatment will recover, provided the weed is taken from them and they are fed well.

Poisoning from horse-tail, Equisetum, has been reported in a number of states. The symptoms are loss in condition, a staggering gait, and increasing weakness. A fatal end rarely occurs if the feed is changed and purgatives are given to rid the system of the poison. A valuable antidote for this and other plant poisons is permanganate of potash; 20 grains dissolved in a pint of water with an equal amount of sulphate of aluminum to increase the acidity of the stomach contents gives best results.

CHAPTER XXI

COMMUNICABLE DISEASES

All communicable diseases are of infectious origin; that is, they are produced by the entrance into the body of pathogenic micro-organisms. These diseases are easily communicated to other animals of the same or other susceptible species by direct contact. They are the chief source of loss to the horse industry. Each is recognized as being caused by a specific or single organism, to which the body reacts in a definite manner by showing characteristic symptoms and lesions. As a rule, the bacteria of these diseases do not produce wound infections following introduction into the tissues. Although our present methods of study have failed to discover a germ for rabies and a few other infectious diseases, it is a foregone conclusion that some form of germ life is responsible for each. The term "virus" is employed to designate the cause of all infectious diseases for which no organism has yet been isolated.

It is important to remember that all diseases caused by infectious organisms are not contagious, although all contagious (communicable) diseases are infectious.

As with the non-communicable diseases, secondary infections are often implanted upon or associated with the primary causes of communicable maladies. Most of the secondary infections are caused by pus organisms. In many cases they gain admission to the blood-stream and are carried to all parts of the body. When an organ with a weak resistance is met, they immediately start to multiply and cause serious interference with its functions, complicating the original disturbance, rendering diagnosis more difficult, and hastening death.

The time which elapses between the exposure of the animal to infection and the appearance of visible symptoms of the disease is called the *period of incubation*. It varies from a few days in very acute diseases to several weeks in chronic affections.

STRANGLES

Strangles, commonly called distemper, is a communicable disease peculiar to young animals of the horse family. It is characterized by fever, profuse catarrh of the nasal mucous membrane, and a marked swelling of the submaxillary lymph-glands.

The *cause* of strangles is the Streptococcus equi. This organism lurks in public sale stables, livery barns, and about places where horses are kept in numbers. In the late winter and spring months these animals are particularly liable to acquire the infection. The period of incubation varies from four to eight days.

The *symptoms* usually noted are the following: Rise of temperature to 104° to 106° F.; general depression; congested mucous membranes; profuse nasal discharge, at first of a watery nature, then thick and yellowish green; moist cough; swelling of the lymph-glands under the jaw—in the beginning they are hard, hot, and very tender, later they suppurate.

Strangles is not a very serious disease. The mortality varies from 1 to 3 per cent. Under ordinary circumstances convalescence occurs in a week or ten days.

Treatment.—A comfortable stall and light, laxative diet must be provided. Of course, the patient should not be kept at work. Clean out the nostrils with moistened absorbent cotton two or three times a day. For internal medication nothing gives better satisfaction than artificial Carlsbad salts. If the fever is high, quinin may be administered. The treatment of the swollen glands in the throat is purely surgical. To hasten abscess formation a poultice may be applied. As soon as the abscess "points" it should be opened with the finger or a blunt instrument to allow the pus to escape. Syringe out the abscess cavity twice each day with 3 per cent. carbolic acid solution.

INFLUENZA

Influenza is known by the synonyms shipping fever, catarrhal fever, and pink eye. It frequently occurs as an enzoötic. No one organism has yet been demonstrated to be the sole cause. One attack produces a life immunity.

The first *symptoms* are like those in other rapidly developing fevers, and include chills, a temperature up to 104° or 105° F., depression, and loss of appetite. These symptoms are seen during

the incubative period, which extends from three to seven days. Later the mucous membranes of the eyelids swell and turn a rosy red color, while tears stream from the eyes. Swellings may occur in the limbs and along the belly.

The usual *course* of the disease is about one week. A favorable termination may be expected in 97 per cent. of the cases. Such complications as congestion of the lungs, bowel troubles, and founder may set in. These often cause death or greatly impair the usefulness of the horse.

Treatment should be prompt and started at the very onset of the disease. Laxative foods must be provided and every precaution taken to protect the patient from drafts and exposure. When the body temperature runs above 105° F. antipyretic treatment is indicated. Potassium iodid is useful as a general eliminating agent. Symptoms are treated as they develop, depending upon the organs from which they arise.

GLANDERS

Glanders is an infectious and contagious disease affecting primarily the respiratory organs of horses, mules, and man. When the skin is the seat of infection the term "farcy" is used to designate the disease. It is more likely to attack animals in a run-down condition than others, as their resistance is weakened.

Cause.—The Bacillus mallei is the only agent capable of causing glanders. This organism gains entrance to the body through the respiratory or digestive tracts, or by inoculation through wounds of the skin. The secretions and excretions of diseased animals are the source from which dissemination always takes place.

Depending upon the manner of exposure and the virulence of the particular strain of Bacillus mallei, the incubation period varies from three to seven days. However, two or more weeks may elapse before clinical symptoms appear.

Symptoms.—The subacute or chronic form of the disease is oftenest seen in the horse. It makes its presence known by a sticky nasal discharge, congestion of the nasal mucosa, cough, intermittent fever, rapid loss of condition, and swelling of the submaxillary lymph-glands, which become hard and sensitive. Farcy buds occur in advanced cases in the skin of the shoulder, neck, and breast (Fig. 69). These quickly suppurate and leave discharging ulcers. Ulcers also appear in the nose; when they

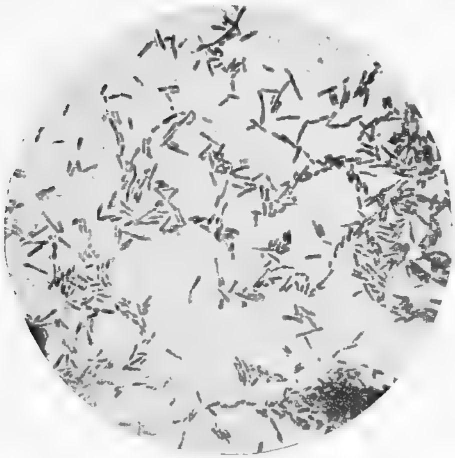

Fig. 68.—The glanders bacillus (Bacillus mallei). Pure culture from glycerin agar. Carbolfuchsin stain × 1000. (Fränkel and Pfeifer.)

Fig. 69.—Glanders or farcy of the skin. The lesions of farcy here shown are found only in advanced cases. (U. S. Department of Agriculture.)

heal, characteristic star-shaped scars are left to mark their location.

A positive diagnosis is made by inoculating the suspect with mallein, either subcutaneously or by introducing it into the eye. Tests on the blood-serum may be made in doubtful cases to clinch the diagnosis.

Treatment is seldom warranted, first, because few recoveries follow, and, secondly, for the reason that once a horse becomes infected he is a source of danger to others with which he comes in contact, even after all visible symptoms of the disease have disappeared; therefore, it is deemed advisable to immediately destroy all affected animals.

RABIES

Rabies is an acute, infectious, and communicable disease affecting particularly the central nervous system. To date no specific organism has been discovered. However, it has been conclusively proved that a filterable virus is the exact and only cause. The disease is almost always communicated through the inoculation of the saliva from a rabid dog. A variable period of incubation is one of the characteristics.

Among the first *symptoms* are restlessness and hypersensitiveness. Later the animal becomes furious, and viciously bites and kicks at any object within reach. The course of the disease is five or six days. Paralysis and death are the inevitable end. Little difficulty should be had in differentiating rabies from other nervous disorders, as in none of them does the horse exhibit the same symptoms of maliciousness. If any doubt exists, small pieces of the brain should be examined by aid of the microscope for the presence of Negri bodies. When found these bodies are considered positive evidence of the disease. In the horse they are very small and usually confined to limited areas.

So far as the horse is concerned there is no treatment. In man an immune serum has been used with success.

DOURINE

Dourine is an infectious disease of the horse and ass, transmitted by the act of copulation and caused by a protozoan parasite, the Trypanosoma equiperdum, which is found as an actively motile organism in the blood.

Until 1912 and 1913 no serious outbreak had occurred in the United States since 1901. In June, 1912, the disease was diagnosed in Montana. It proved to be so extensive that on February 23, 1914, Congress granted $100,000, or as much thereof as would be needed, to investigate, treat, and eradicate it.

At last report 1168 cases had been pronounced infected by the aid of the complement-fixation test. Of these 932 were mares, 222 stallions, 7 geldings, and 7 jacks.

Symptoms.—There are many variations in the symptoms of dourine, so it is impossible to describe a single case and at the same time convey a good idea of the disease. Among the usual symptoms in the stallion are an irritation and swelling about the penis and soreness of the glands in the groin. Soon vesicles appear and break, leaving irregular raw ulcers, which heal rapidly but leave permanent white scars. In the mare somewhat similar symptoms occur.

The disease has a course running from nine months to two years, so is a typical chronic affection.

Now and then a case of dourine recovers, but the prognosis is unfavorable. European investigators say 70 per cent. die.

Treatment.—Medical treatment is of little benefit. Infected horses must be excluded from breeding, and had best be immediately destroyed to prevent communicating the disease to others of their kind.

ANTHRAX

Anthrax is an infection due to the anthrax bacillus. It may attack the horse, but more often other species of the domestic animals are infected. The germ is found in the soil, on the forage, and in the water of stagnant pools, where it may exist in the spore form for many months. It gains entrance to the body through the digestive or respiratory tracts or through wounds.

Anthrax in the horse is most commonly met with as a subacute, febrile disease. The chief *symptoms* are fever, prostration, drowsiness, staggering gait, convulsions, and death. When infection occurs in the skin carbuncular swellings develop.

A postmortem examination shows a tar-like blood, greatly enlarged spleen, congested lymphatic glands, and blood extravasates throughout the body. The disease is positively identified by making a microscopic examination of the blood, in which large

numbers of the characteristic bacilli will be found if the animal is infected.

As *treatment* is usually out of the question, much importance attaches to the prevention of this disease. In addition to precautions for guarding the food and water against contamination there are a number of methods of producing immunity. The most generally used method was developed by Pasteur. It consists in two subcutaneous injections of attenuated cultures of the bacillus of anthrax at an interval of twelve or fourteen days. The inoculations must be repeated each year to keep the immunity of the animal at a point sufficiently high to withstand natural infections.

The blood-serum of animals rendered hyperimmune to anthrax has been used both as a prophylactic and therapeutic agent. When used in conjunction with the vaccine the chances for perfect immunity without loss are greatly increased.

TETANUS

Tetanus is a typical acute, infectious disease of the nervous system, characterized by spasmodic contractions of the muscles. It is caused by the tetanus bacillus, a spore-forming, toxin-producing organism that is naturally found in certain soils and plentifully in the mold of horse manure. The horse possesses great susceptibility for virulent cultures. Infection occurs through wounds made by fork-tines, nails, splinters, or infected surgical instruments. Strictly speaking, it is not a communicable disease, although pus from an infected wound is nocuous.

The *period of incubation* varies from two to five days. Then the animal shows spasms of groups of body muscles. When those of mastication are affected the jaws become immovable. This has given rise to the term "lockjaw." The ears, tail, and limbs stiffen. Chief among the diagnostic symptoms is the protrusion of the membrane nictitans, or "haw," over the eyeball when the head is raised. A stilty attitude is assumed and a stiff gait when in motion.

The mortality varies between 55 and 90 per cent. In mild cases given prompt treatment recovery may be expected. Thorough disinfection of the seat of infection is the first essential in treatment. Quiet quarters and provision for comfort are of greater importance than drugs. Injections with an antitetanic serum give

fine results as a prophylactic, but are less beneficial after the symptoms have become well marked.

NAVEL ILL

Navel infection results in an acute, infectious disease that is technically known as pyemic arthritis. It is characterized by purulent inflammation of the joints.

The cause appears to be an organism of the colon-typhoid group which is carried by the blood-stream from the navel, where the infection takes place, to the joints, lungs, and liver. There is good reason to believe that this same organism may cause contagious equine abortion.

The *symptoms* appear twenty-four to forty-eight hours after infection has occurred. The foal refuses to suck and has a fever. The joints become hot and swollen, and the young animal moves with difficulty or lies stretched out flat on its side. There may be no signs of inflammation at the navel; in other cases considerable pus can be squeezed out of it.

A mortality averaging 50 per cent. is to be expected. Often death occurs in three or four days. In chronic cases the foal may live a miserable existence for three or four months. If the disease does not appear until the animal is several weeks old the chances of recovery are better.

Prevention is of more importance than treatment. It can be accomplished by disinfecting the navel immediately after the navel cord breaks, and twice a day afterward until it dries up, drops off, and no raw spot remains. A shallow, wide-mouthed bottle should be nearly filled with a 1 : 500 solution of corrosive sublimate or tincture of iodin and the navel stump immersed in it. To keep the disinfectant from blistering the foal's belly, smear vaselin on the skin around the navel before applying the solution.

Death may often be averted by opening and disinfecting the affected joints, but there is a decided probability that the joints will be stiff. Stimulants to sustain the heart and medicine to control digestive disorders, frequent complications, must be provided.

TUBERCULOSIS

Tuberculosis is a communicable, infectious disease characterized by the formation in the internal organs of very small nodules or tubercles that have a tendency to undergo caseation.

The disease is occasionally seen in the horse, but cattle and hogs are much oftener affected. In some herds of cattle as high as 80 per cent. of the animals have been found infected.

This malady is caused by the tubercle bacillus discovered by Robert Koch in 1882. The organism is extremely small and belongs to the acid-fast group. It is difficult to isolate directly from the tissues. On artificial media it grows slowly.

Infection is usually acquired by eating food or drinking water that has been contaminated by discharges from tubercular animals. Lesions of the disease appear first in the digestive organs. Later, the blood-stream may carry the bacilli to the lungs and other parts of the body where secondary foci of infection develop.

The *symptoms* of equine tuberculosis are similar to those exhibited by other classes of animals suffering from the chronic form of the disease. One of the commonest features is a gradual wasting away. This is followed by death after a period of months or sometimes years of ill-health. The history often points to the disease having set in after an attack of influenza. When confined to the lungs a cough and some difficulty in breathing occur and may be the only signs noticeable for many weeks. If the intestines are infected, digestive disturbances are present and absorption is interfered with. Chronic, persistent diarrhea is a marked symptom in advanced cases.

A biologic test is used to determine the presence of infection. It consists of injecting tuberculin, a solution of the products of the tubercle bacilli, into the body of the suspect. If the animal is infected, a rise of temperature of more than 2° F. occurs a few hours after the injection. The tuberculin test is recognized as a reliable method of diagnosis. It is not infallible or fool-proof, but is much more satisfactory than a diagnosis based entirely on a physical examination. Horses with a temperature higher than 101.5° F. should not be tested. The dose of tuberculin is similar to that employed for cattle, viz., 2 c.c. per 1000 pounds of weight. A firm swelling nearly always appears at the point where the tuberculin was injected if the horse is tuberculous. It disappears in from eighteen to twenty-four hours.

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